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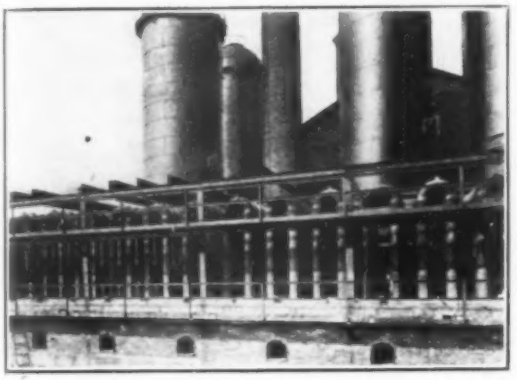
Castings Recover Heat for the Blast Furnace

A NEW departure in the design of blast furnace equipment is found in the Dovel type recuperator used by the Sloss-Sheffield Iron & Steel Co., Birmingham. Although the idea of a recuperator is new in blast furnace practice, the principle has been used in steam-electric generating stations



Courtesy of the Cast Iron Piper

Cast Iron Pipe Made in Centrifugal Molds Carries the Air in the New Blast Furnace Recuperator

where it is called an economizer. The recuperator is designed to recover a portion of the energy ordinarily lost in waste heat in the chimney and transform it into useful work. This is accomplished in a long brick chamber which is lined with a heat insulating material. Inside the chamber, cast-iron pipe made by the de Lavaud centrifugal process, are placed in a vertical position and are connected at the top and bottom by cast-iron, U-bends. The unit is constructed to give eight or more parallel lines and each line having 30 lengths of the cast-iron pipe. Hot gases from the flues enter the recuperator chamber at one end, circulate around the coils and escape into the air through a chimney at the opposite end. Air from the blowing engines passes through the lines in the recuperator chamber before entering the stove. Tests have shown that the temperature of the air is raised approximately 270 degrees Fahr. when passing through the chamber.

Find Where Castings Can Be Sold.

CONTENTS

FEATURE ARTICLES

	Page
Reproduce Ancient Sphinx in Aluminum Alloy—By Pat Dwyer	826
Improve Process for Casting Pipe Centrifugally in Green Sand Molds—By Giuseppe Guerrini	832
Alloy Steel Castings Meet Demands of Engineering Development—By J. W. Frank	836
Englishman Discusses Gray Iron	838
Charles Vickers Says Deoxidizers Should Be Used Discreetly	839
Effects Savings in Production of Heavy Gray Iron Castings—By E. C. Kreutzberg	842
Melting Iron in The Cupola—Part IV—By J. E. Hurst	848
Bill Comments on the Lost Wax Process—By Pat Dwyer	855

REGULAR DEPARTMENTS

How and Why in Brass Founding — By Charles Vickers	847	**Trade Trends in Tabloid**	861
What Others Are Thinking	853	**Comings and Goings of Foundrymen**	862
Queries on Foundry Practice	858	**What the Foundries Are Doing**	864
The Shakeout	860	**New Trade Publications**	864

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REPRODUCE A

IN ALUMINUM A

Fig. 1—Overlooking the City on One Side and the Broad Mississippi, Two Aluminum Figures Dominate the New St. Louis Court House

REVIVAL of an old, old note in architecture was struck recently when a pair of large aluminum figures of the Sphinx were erected as the cap sheaf, the crowning ornament on the new civil courthouse in St. Louis, nearly 400 feet above the street level and approximately 500 feet above the normal level of the Mississippi, one of the three or four great rivers on earth and comparable in this instance with the Nile which flows through the ancient land of Egypt and along the banks of which the Sphinx first came into existence and where it still may be seen to this day.

For many years to come, how many, no person knows, these two personifications of peace and dignity will continue to gaze out in flood time and drought over the broad and deep waters of the yellow bow which bounds the city of St. Louis on the east and which for hundreds of miles serves as a boundary between the states of Missouri and Illinois.

An architect's whim in this twentieth century recreated and conferred prominence on a modification of this figure always presented with the body of a lion, but with the head either of a man, a ram or a hawk which loomed large in the mythology of Egypt for over 4000 years. The Sphinx was evolved in the Old Kingdom, came into full recognition and prominence in the Middle Kingdom and continued down through the years of the Empire. Thus paralleling closely the fortunes and course of a nation commencing in pomp and glory and closing in misery, abasement and defeat as a tributary colony first to Persia and later to Rome.

The Pharaohs to whom the unparalleled grandeur of the Old Kingdom was due, not only gained a place among the gods in their own time, but priests were appointed to maintain their worship up to a period 2000 years later when the history

Fig. 2—The Separate Sections Were Tried and Assembled at the Foundry. Fig. 3—Working from a Small Model, the Sculptor Reproduced the Figure to Full Size

Ancient Sphinx

ALLOY

By Pat Dwyer

Fig. 6—Working to Conventional Form, the Sculptor Has Interpreted the Brooding Dignity of the Ancient Figure

of Egypt as an independent nation ceased in the twenty-sixth dynasty. At the end of her career when the nation had lost all that youthful elasticity and creative energy which so abounded in the Old Kingdom, the sole effort of the priests and wise men was to restore the unsullied religion, life and government which in their fond imagination had existed in the Old Kingdom as they looked back upon it wistfully from across the chasm of 2000 years.

Imposing line of tombs, temples and pyramids, stretching for many miles along the margin of the western desert constitutes the most eloquent witness to the fine intelligence and titanic energies of the men who made the Old Kingdom what it was. Men who achieved wonders of mechanics and internal organization, who built the earliest known sea-going ships, explored unknown waters and pushed their commercial enterprises far up the Nile into equatorial Africa.

In plastic art they had reached the highest achievement. In architecture their tireless genius had created the column and originated the colonnade. In government they had elaborated an enlightened and highly developed state with a large body of law. In religion they already were dimly conscious of a judgment in the hereafter and thus were the first men whose ethical intuitions made happiness in the future life dependent on character. Everywhere their unspent energies unfolded in a rich and manifold culture which left the world a more priceless heritage than that bequeathed by any other nation.

The Sphinx, like the obelisk in the mythology of ancient Egypt, represented the solar Deity Ra and originally were placed like the obelisks in pairs at the entrance of temples and palaces, not for ornamental purpose only, but mainly for worship. Hundreds of them in various sizes line the avenues leading to temples and palaces of Thebes and Karnac. Greatest of all and one most familiar to the general public is carved from the solid rock located about 1800 feet from the largest pyramid. It is 140 feet in length, 65 feet high at the highest point and 29 feet in width across the front. In other words it is approximately the size of a 6-story brick or stone building, tapered down toward the back and without basement or water tower.

Conditions in American cities differ to some extent to those which prevailed in Egypt during

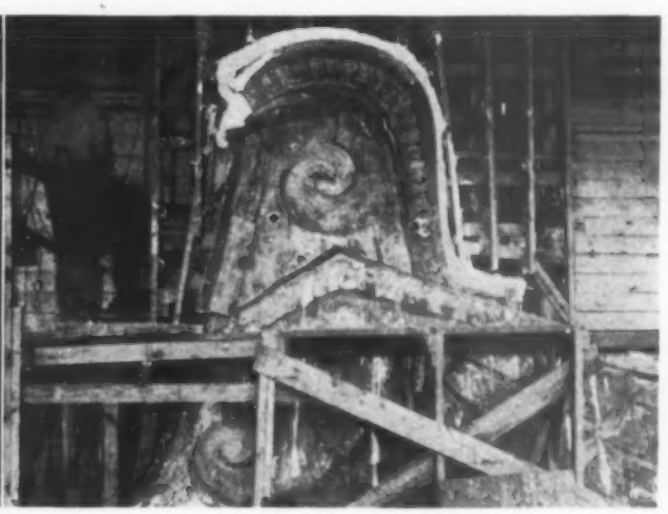


Fig. 4—Framework Was Constructed Against the Large Model to Support the Plaster Matches. Fig. 5—An Idea of the Size of the Figure Is Shown by Comparison

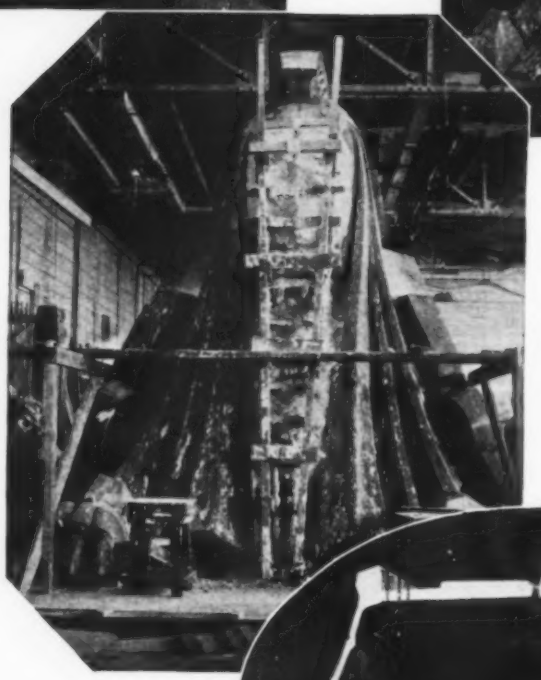


Fig. 7 (Above)—Preparing the Wood Frame for the Impression. Fig. 8 (Right)—Plaster Was Thrown Against the Face of the Model to Take the Impression for the Pattern. Fig. 9 (Below)—The Complete Plaster Model from Which the Patterns Were Made

Fig. 10 (Above)—Front Section Complete, Ready for Removal from the Model. Fig. 11 (Below)—Several Sections of this Casting in Process of assembly

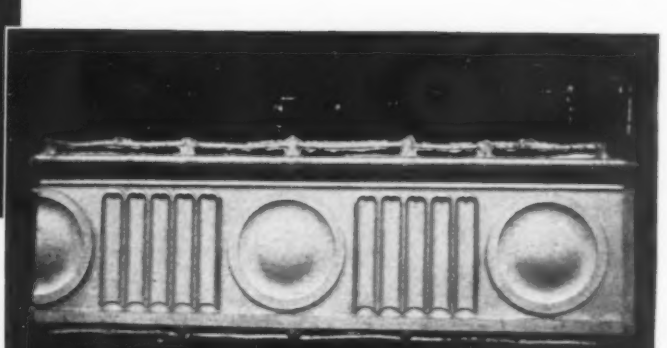


Fig. 12 (Right)—Section Showing Detail and Gating of the Base Panel Supporting the Figure

this far away period, the long centuries while the Pharaohs ruled with an iron hand from the Delta on the north to the country now known as the Sudan far to the south, beyond the fourth and last cataract of the Nile.

Monuments have withstood wars of aggression and invasion, floods, famine and the swirling sand storms of the desert for 4000 to 6000 years. So far as present knowledge extends, based on experience and test, the two large aluminum alloy figures surmounting the new civil courthouse in St. Louis, certainly will outlast the building. No data are available from which to calculate the actual life expectancy of this metal, but it is interesting to note that aluminum alloy castings made over 20 years ago and constantly exposed to the weather since that time, show no sign of corrosion. On samples now in the possession of the Aluminum Co. of America, Pittsburgh, the saw and file marks in the vicinity of the gates are as clear and distinct as they were on the day the gates were removed from the castings.

In the natural evolution of a great city which involves a constant tearing down and building up, the element of chance probably will send these figures through the melting furnace in 100, 200, perhaps 300 years. Who knows? A chance also exists that they will remain above ground for 2000 or 3000 years, to excite the attention, admiration and curiosity of some learned antiquarian of the future and lead him to the conclusion that the Egyptians first settled the valley of the Mississippi.

Many of the interesting features of the two large decorative figures recently completed at the plant of the United States Aluminum Co., Cleveland, are shown in the accompanying illustrations and are supplemented by the following figures which will indicate to the practical foundryman the character of the problem that was presented in reproducing such large castings in aluminum: Total length, 19 feet 10 inches, greatest width 12 feet and extreme height 11 feet 9 inches.

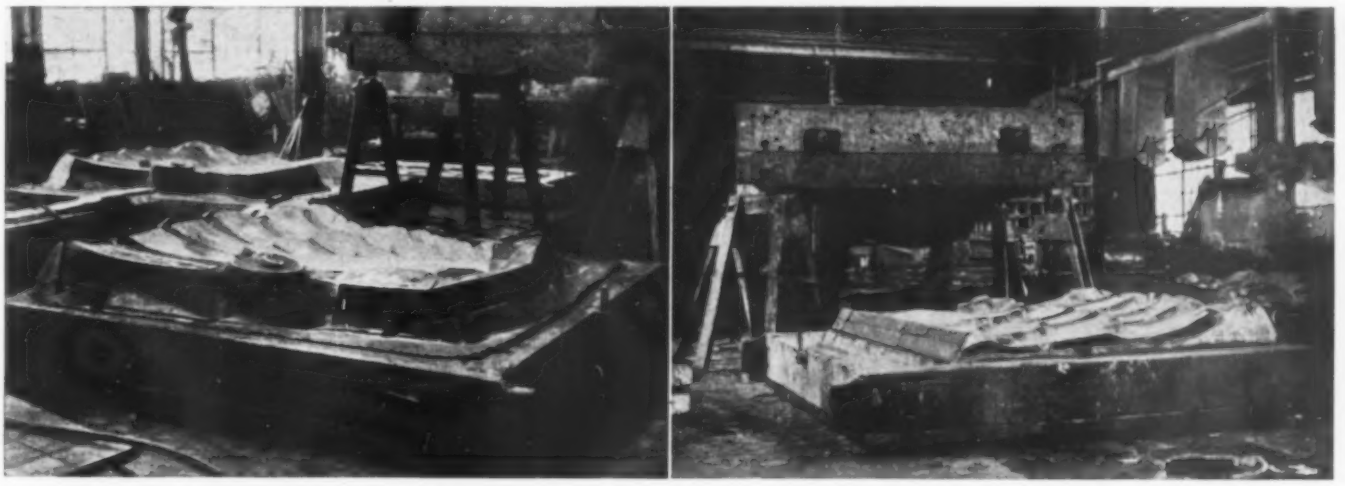
The castings were molded and poured in green sand. Methods followed by the United States Aluminum Co. in handling a widely diversified line of large and difficult castings, led in this instance to the adoption of the ingenious pattern equipment shown, which makes this job so unusual and interesting to foundrymen. The peculiar and uneven surface, large area and thin metal section of the proposed castings, introduced a hazardous element into the proceedings and called for an exceedingly high degree of care, skill, knowledge and accurate workmanship. Several of the castings were molded in turn in a flask 9 x 11 feet and while this is considerably larger than the average flask employed in this foundry, it by no means constitutes a record.

For many readers it will be sufficient to state that a full size plaster figure was erected in the pattern shop. Lines on the surface of this figure divided the area into 13 sections, some large, others small, but all based on the general plan of facilitating molding and later assembling the complete figure in the most convenient manner. A plaster impression was taken from each section. A second plaster impression was taken from the first and these two constituted what corresponds to a cope and drag impression of an ordinary mold. These plaster patterns were taken into the foundry where a sand cope was rammed on one and a sand drag upon the other. The two half sand molds then were assembled in the usual manner. In its essentials the plan was simple, but many interesting features were developed in carrying out the details. First and last the job occupied the time of a crew of molders and patternmakers for six months besides the time of the supervising artist who made and finished the various plaster parts.

To begin at the beginning, which for all practical purpose means where the architect accepted the design for this ornamental feature on top of the building, a sculptor was commissioned to prepare a ¼-size model, first in clay and then in plaster. The plaster model was shipped to New York where special facilities are available for producing reproductions on any desired scale. A wood skeleton was erected conforming approximately to the desired shape and size and divided into several sections for convenience in shipping. Wire netting was spread over one face of the frame and guide points were established closely all over the frame by driving nails in the wood members. Position of these nail heads was determined by a device commonly used in studios for the purpose of securing duplicates to any desired scale.

With the frame properly constructed and with the nail heads to serve as guides the rough plaster was applied to form an approximation of the desired figure. A little extra material was allowed all over to give the sculptor some leeway in finally bringing the figure to the correct shape and finished appearance. The completed figure then was taken apart and shipped with the original ¼-size model to the plant of the United States Aluminum Co., Cleveland.

Each part was finished carefully by hand by the sculptor as may be noted in Fig. 3. Gradually as each



Figs. 13 *and* 14—*One of the Green Sand Molds for the Wings, Made in a Wood Flask,* 9 *x* 11 *Feet*

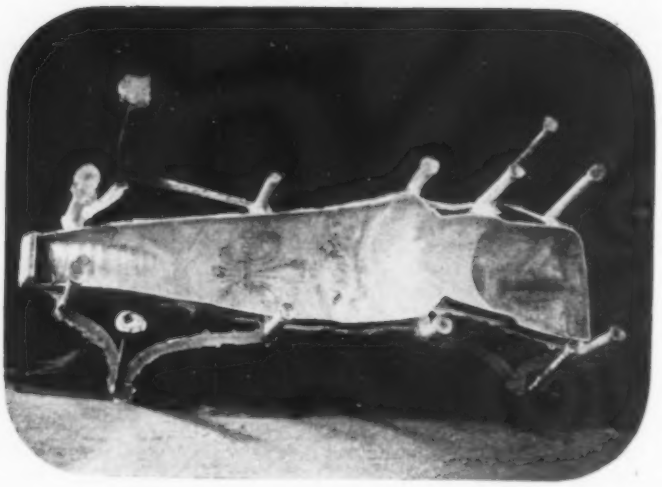
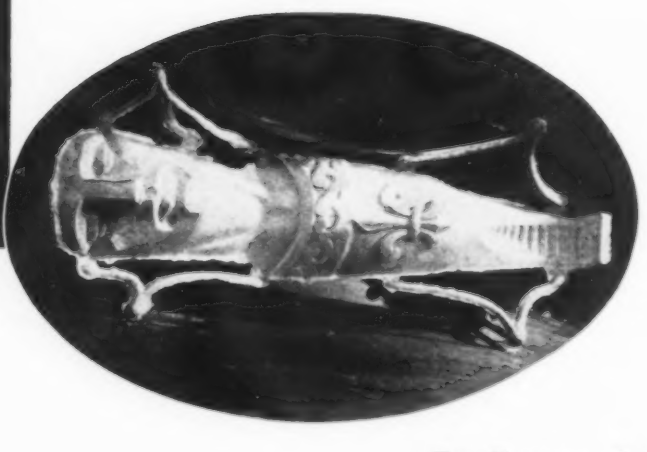


Fig. 18 (*Above*)—*Cope Side of the Front Castings. Fig.* 19 (*Below*)—*Plaster Pattern for Drag Side of the Front Casting*

Fig. 15 (*Above*)—*Plaster Pattern for the Cope. Fig.* 16 (*Right*) — *Plaster Pattern for the Drag Showing Method of Coring Undercut Edge*

Fig. 20 (*Below*)—*The Front Castings Were Poured at Four Corners*

Fig. 17 (*Above*)—*Completed Wing Casting, Showing Method of Gating*



piece was finished it was erected in proper position until finally the entire figure occupied a place as a finished unit in the center of the pattern shop. Since the shop never had been designed to handle work of this character, the crest on the head of the figure extended almost to the roof beams. A block and tackle attached to one of the beams served to handle the heavy frames. By the time the upper pattern frame was erected as shown in Fig. 4, clearance between frame and beam practically was exhausted.

A general idea of the magnitude of some of the operations may be gained from the statement that 15,000 pounds of plaster was consumed in making the main pattern, while 18 tons more was required to form the plaster matchplates that went into the foundry to serve as patterns. In addition to a mass of smaller pieces of which no account was kept, 14,000 feet of 2 x 4-inch lumber was employed in making the frames to support these plaster matchplates. In ordinary practice, plaster matchplates are prepared in a horizontal position. The added difficulty involved in this job will be appreciated when the fact is taken into account that the matchplates had to be erected and prepared in a vertical position as shown in Figs. 4, 5, 8 and 10.

For the benefit of readers who may not be familiar with the methods usually employed in foundries which handle this class of castings, particularly in bronze, it may be said that the original plaster pattern, cut into suitable sections, is all that is required. Each section is suitably mounted so that it may be molded in the drag half of an iron flask either by bedding in or rolling over. The pattern then is removed. The face of the mold is covered with paper or parting compound. The cope is adjusted in place and the sand in the cope is rammed directly against the sand face of the mold in the drag. The cope then is removed and a sufficient amount of sand is shaved from the face to form the cavity for the metal. The principal objection to this method is that it can be trusted only to the hands of highly skilled molders, familiar with all the details through many years' experience. Ordinary molding sand in a drag will not hold the shape of the mold face under the battering incident to ramming a cope against it. A special species of sand imported from France, which hardens upon exposure to the atmosphere is the only satisfactory material so far available. Molds made in French sand are dried involving a large mold oven installation.

The United States Aluminum Co. decided the castings could be made according to the double plaster impression method shown in the various illustrations, in green sand molds and in sand which comes from the Albany district, New York state. That the idea possesses merit is proved by the fact that all the castings turned out satisfactorily. A still more remarkable feature is that none of the castings was warped or twisted. The assembly crew experienced no difficulty in fitting the various sections together in the plant yard as may be noted in Fig. 2. Cost of preparing the pattern equipment was greater than that involved in what has been regarded as the standard method of molding this class of castings. Advantages claimed for the new method are that it practically removes all hazard from the job in the foundry. Also the patterns are permanent and may be used again in the foundry at any time orders are received irrespective of the personnel of the molding force.

The figure shown partly assembled in Fig. 2 indicates clearly the manner in which the pattern was divided. Six of the 13 casting sections are shown in place and the imagination easily can supply the missing parts by referring to the original plaster pattern shown in Figs. 6, 9 and 22.

(*Concluded on Page* 854)

Fig. 21—*Method of Building Frame and Applying Plaster for Wing Pattern.* *Fig.* 22—*Front View of the Completed Plaster Model*

Improve Process for
Casting Pipe Centrifugally
in Green Sand Molds

By Giuseppe Guerrini

MANUFACTURE of cast iron pipe by the centrifugal method has become a problem which keenly interests those specializing in foundry work. The principle of casting metal by centrifugal means is not new since early in the nineteenth century an Englishman named Eckhardt attempted the centrifugal casting of pig iron by causing a sand mold to revolve.

Results obtained were neither practical nor economic, due perhaps to the fact that physical, chemical and mechanical knowledge at the time was not sufficently appreciated in foundry work. The old school did not know how to translate practical knowledge of various sands and pig irons into figures which would indicate the chemical analysis, resistance, permeability, and cohesiveness of the sand, etc.

Early in the twentieth century, 100 years after Eckhardt's experiments, the problem of making cast iron pipe by centrifugal methods was approached again from quite a different angle, using a metallic or permanent mold in place of a sand mold. Practical results were obtained from patents of two Brazilians, Arenz and De Lavaud. Later other advances were made by American, British, German inventors and an Italian engineer, Ercole Galassini, whose process is being used by an important metallurgical establishment in Italy.

The quality of the metal used for making the permanent mold exerts an enormous influence on the manufacture of pipes cast by the centrifugal method. Attention of technicians has turned to this point and has resulted in experiments upon the use of permanent molds made of tungsten steel.

Solve Many Problems

Recently, developments have been made in the centrifugal casting process for which two Italians, Engineer Possenti and Mr. Scorza, and an American, W. D. Moore, are responsible. These inventors again took up the work of Eckhardt, with the help of modern mechanical methods, and although working along different lines they arrived at interesting solutions of the problems.

Both the methods of centrifugal casting, namely the permanent mold and the sand mold are based upon the same principle, namely the pouring of the molten metal against the wall of a mold to which rapid rotation is imparted.

Advantages are claimed for the centrifugal process of casting pipe, including saving of time owing to the elimination of the central core, and a uniform thickness of metal. In addition an appreciable increase in the mechanical strength of the metal over other methods of manufacture is claimed. The most important point gained by the centrifugal method of casting is the uniform distribution of the whole quantity of metal all over the mold.

In casting centrifugally in sand molds, the problem of the distribution of the metal is rather more complicated. Apart from the uniformity required for the good distribution of the metal over the whole length of the mold, it also is necessary to carry out the work almost instantaneously to prevent any deformations of the mold.

The method developed by Possenti and Scorza is used at present at the Foundry Works of the Montecatini Co., Pesaro, and at the important Necchi Foundry, Pavia. Other plants have been installed in Spain, France, Belgium, Holland, Brazil, the Argentine and Germany. The plant at Pesaro is small and consists of the orignal machine invented by Possenti and Scorza. This machine which is shown in Fig. 1, is capable of producing centrifugally cast pipes having an internal diameter ranging from 7.87 to 13.78 inches and up to 13 feet in length.

With 12 flasks it is possible at that plant to produce from 5 to 7 tons of pipe in 8 hours. Rejections, which are not due to any defect in the principle but rather to lack of attention on the part of the workers, represents something like 3 to 6 per cent.

The Pesaro plant was constructed on the first Possenti-Scorza patents and

A. POSSENTI

C. SCORZA

it furnishes a demonstration of the method. An examination of the latest designs prepared for the Necchi Foundry and for installations in France, shows that these are of great simplicity. The machines designed on the new plans will permit a large production with low labor costs since practically all movements now have been made automatic. It is expected that with the improvements introduced it will be possible to manufacture pipe in 5 to 8 minutes, depending on the diameter.

The plant for centrifugal casting used at Pesaro comprises a compressed air molding machine upon which one or four flasks are placed to form the molds. The flask is of a special design, a portion of it being detachable, so that after the metal has been cast centrifugally that portion may be removed easily. This is accomplished automatically so that the pipe may be withdrawn readily.

The compressed air machine is of the type made by the Tabor Mfg. Co., Philadelphia. It has a lifting capacity of 17,600 pounds and was constructed at Frankfort, Germany, by the firm of Kretschmer. When the mold has been formed and laid horizontally, its face immediately is covered with a layer of special blacking, finely spread, while an electric heater dries the moisture to a certain depth in the mold. This procedure is known as skin drying in the United States.

The flask with the mold then is fixed in the centrifugal casting machine, and after the introduction of the filtering feed runner the metal is poured while the machine is being rotated at the number of revolutions required for the particular size of pipe being made.

When the centrifugal casting is finished the flask is removed from the machine, and the pipe withdrawn from the flask. The pipe, which still is a cherry red, is allowed to cool slowly on the cooling platform, with some sand still adhering. The sand subsequently falls off when the pipe is cold, due to the layer of special blacking. The flask immediately is returned to the molding machine, and the cycle of operations is continued. This is important since the number of flasks used is comparatively limited.

Metal is melted in a cupola having a capacity of 5 tons per hour. This cupola also supplies the metal required for the various departments of the Pesaro Foundry Works. Charging the cupola is under rigorous control. The charge consists of carefully weighed quantities of No. 3 Luxemburg iron, medium phosphorus Scotch iron, and machinery scrap which produces a grade of iron suitable for the pipes cast.

The chemical analysis of pipe produced is as follows: Total carbon 3.20 per cent; graphitic carbon 2.80 per cent; combined carbon 0.40 per cent; silicon 2.33 per cent; manganese 0.73 per cent; phosphorus 1.28 per cent; sulphur 0.064 per cent. When tested for tensile strength, five bars having an analysis as shown averaged 32,000 pounds per square inch.

Sand preparation methods exert an important influence upon the result obtainable by centrifugal casting. At Pesaro, an Italian sand is used which has excellent properties with regard to refractoriness, permeability, cohesiveness, etc. The chemical analysis of the sand is as follows: Moisture 9 per cent; loss due to burning 4.5 per cent; SiO_2, 72.20 per cent; Al_2O_3, 12.08 per cent; Fe_2O_3, 4.80 per cent; MgO, traces; CaO, 0.57 per cent; losses (unmeasured substances) 1.15 per cent.

An important feature of the method is the runner through which the metal is poured. This has been devised to supply metal almost instantaneously throughout the length of the mold. Pouring of the metal for a pipe 10 inches in diameter and 13 feet long, will require approximately 10 to 15 seconds, depending on the temperature of the molten metal. The feed runner also is designed to filter the metal, thereby retaining the major part of the slag which will be present even in a carefully cleaned ladle. Filtration of the metal gives a clean surface inside.

Particular emphasis is given to the temperature and fluidity of the metal because it is upon these factors that the uniformity of the thickness throughout the length of the pipe will depend, even if the pipe is thin. It has been the intention to devise not only a runner capable of withstanding a large number of pouring operations, but also one from which all slag may be removed quickly after casting.

An important feature of the process is the saving in the initial cost of the plant. A project now under consideration comprises 12 centrifugal casting machines for the manufacture of exhaust and rain-water pipes, three molding machines with the necessary molding equipment, a number of flasks required for continuous production, patterns, equipment for the preparation of the sand, valves for all the automatic drives, etc., and the estimated expenditure is about $40,000. The plant will be capable of producing between 12 to 15 tons of centrifugally cast pipe in 8 hours.

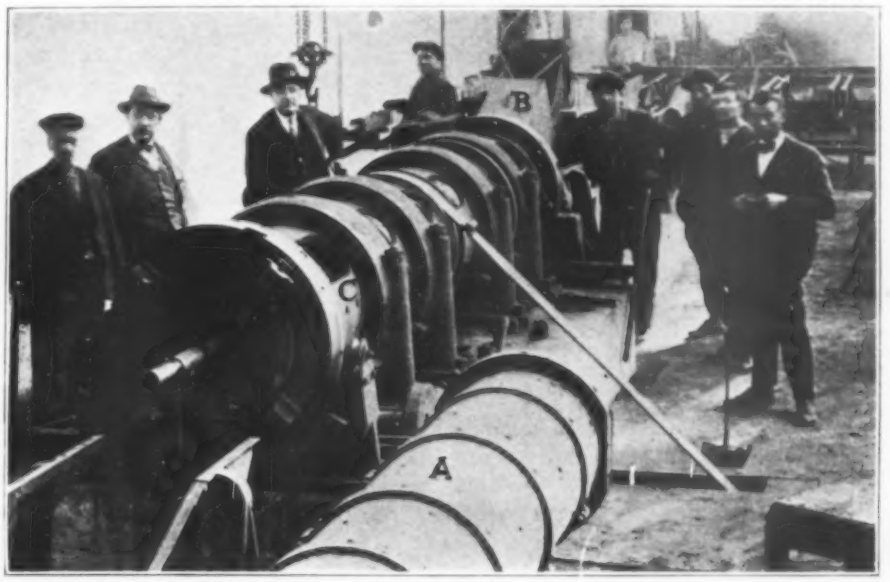
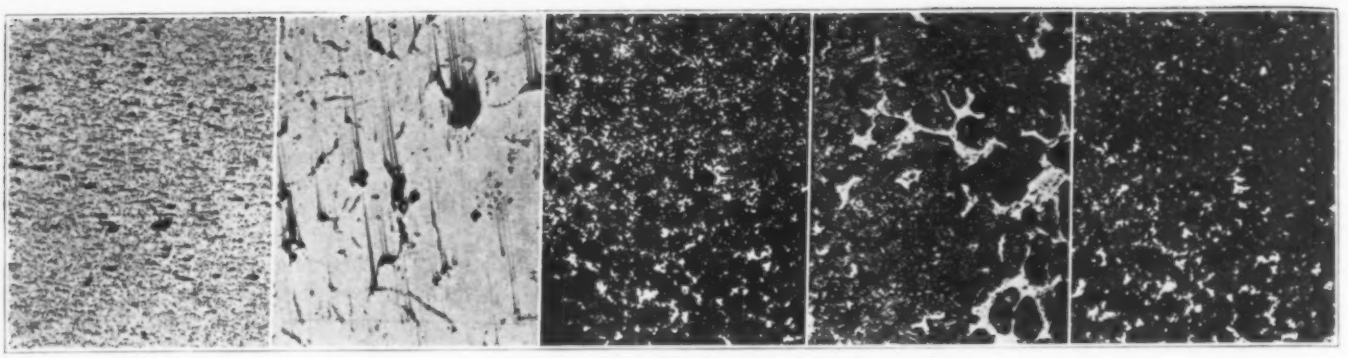


FIG. 1—THE PERMANENT MOLD MACHINE DESIGNED BY POSSENTI AND SCORZA. *A* SHOWS THE FLASK, *B* THE POURING BASINS AND *C* THE SPINNING OF CENTRIFUGAL CASTING MACHINE

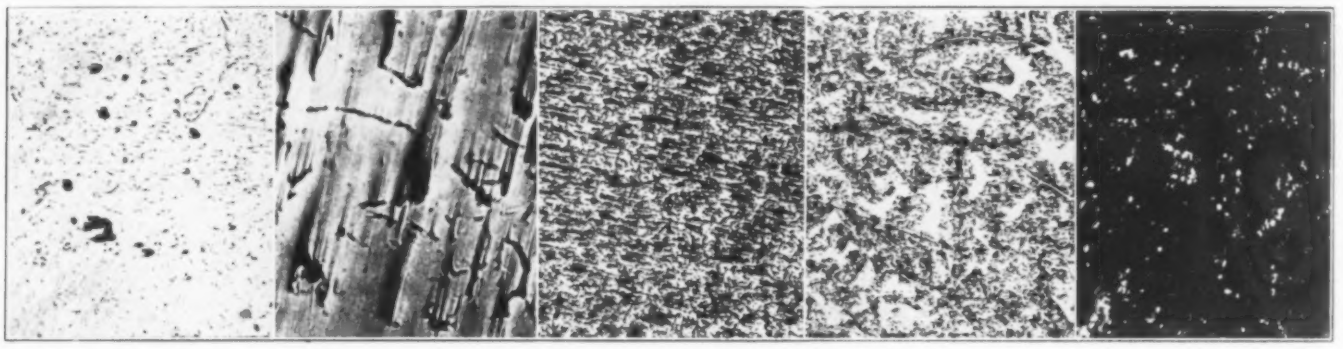
Another feature of the process is that in addition to producing pipe of various diameters, it also is possible to make pipe of different lengths. After a few revolutions, the metal begins to assume a tubular shape under the influence of centrifugal force. Owing to the porous nature of the sand, any vapor formed between the metal and the internal surface of the mold permeates the layer of sand and condenses. The wall of the flask is provided with suitable outlets through which vapor may escape.

In the Italian process the machine is rotated at a greater speed than the permanent mold centrifugal casting, since the metal remains for a longer period in the physically pasty



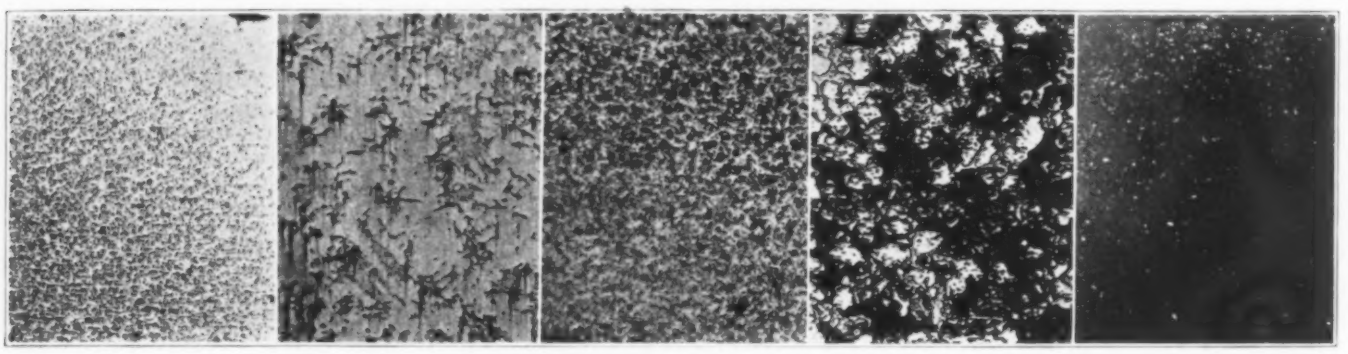
CENTRIFUGALLY CAST BY POSSENTI-SCORZA PROCESS

Fig. 2—Distribution of Graphite—Unetched—X 9. Fig. 3—Graphite Distribution—Unetched—X 90. Fig. 4—Pearlitic Structure—Etched—X 9. Fig. 5—Ferrite in Ground of Fine Pearlite—Etched—X 90. Fig. 6—Phosphide Distribution—Etched—X 9



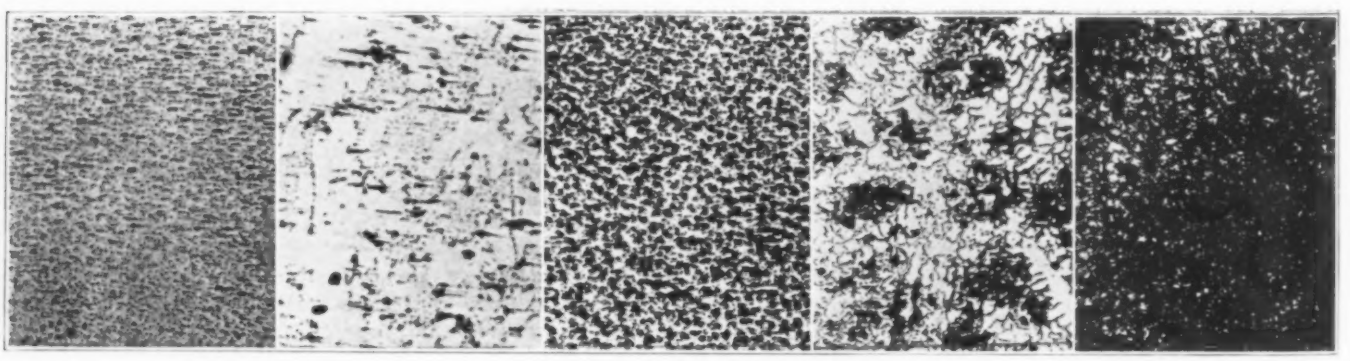
PIT CASTING PROCESS

Fig. 7—Graphite Distribution—Unetched—X 9. Fig. 8—Graphite Distribution—Unetched—X 90. Fig. 9—Pearlitic structure—Etched—X 9. Fig. 10—Ferrite in Ground of Fine Pearlite—Etched—X 90. Fig. 11—Phosphide Distribution—Etched—X 9



CENTRIFUGALLY CAST BY ARENZ PROCESS

Fig. 12—Carbon Distribution—Unetched—X 9. Fig. 13—Carbon Distribution—Unetched—X 90. Fig. 14—Ferritic Structure—Etched—X 9. Fig. 15—Ferritic Structure—Etched—X 90. Fig. 16—Absence of Phosphorus—Etched—X 9



CENTRIFUGALLY CAST BY DE LAVAUD PROCESS

Fig. 17—Carbon Distribution—Unetched—X 9. Fig. 18—Carbon Distribution—Unetched—X 90. Fig. 19—Temper Carbon Accumulations—Etched—X 9. Fig. 20—Temper Carbon Accumulations—Etched—X 90. Fig. 21—Phosphide Distribution—Etched—X 9

state during the green sand centrifugal casting process. The peripheral velocity has been determined in advance for every diameter made. Apart from this the peripheral velocity will vary with the thickness, even when pipes of equal diameters are produced.

To insure perfect pipe, it is necessary to exert constant supervision over the temperature of the metal when it is being poured into the revolving mold. With the filtering runner, all impurities in suspension in the liquid, or formed in the ladle owing to the presence of the refractory lining, are reduced to a minimum, so that even the interior of the pipe is kept quite clean. Any small quantity of slag present is carried away by the rapidly flowing metal owing to the difference between its specific weight and that of the metal.

A pipe 0.118 inches thick under test has withstood a pressure equal to 368 pounds per square inch and another 0.278 inches thick has withstood a pressure of 735 pounds per square inch. The pipes tested had internal diameters of 5.9 and 9.8 inches and lengths of 6½ and 13 feet.

The problem of the casting pipe centrifugally in green sand requires a good mechanical training and a good knowledge of foundry work generally. Attention must be directed chiefly to the mixing of the various grades of iron, the mixing of the numerous classes of foundry sand and the calculation of the peripheral velocities, so that the centrifugal force applied shall not be such as to cause any deformation of the mold. In addition to these factors careful consideration must be given to the determination of the quantity of moisture required for the cohesiveness of the sand, which must not be excessive or such as to impair the efficiency of the centrifugal process.

Shows Metal Structure

Figs. 2 to 21 give comparative micrographs relating to the Possenti and Scorza method of green sand centrifugal casting; the normal method of pit casting; the Arenz method of permanent mold centrifugal casting (tempered pipe); and the De Lavaud method of permanent mold centrifugal casting (tempered pipe). These micrographs were obtained through the courtesy of Prof. Dr. Pisek, of the Czechoslovakian Polytechnic school, Brno, who has made a special study of the manufacture of cast iron pipes.

The micrographs shown in Figs. 2, 3, 4, 5 and 6 are those of pipes centrifugally cast by the Possenti and Scorza method which consists of high quality pearlitic cast iron. Fig. 2 shows the section of the pipe magnified 9 times, in which the regular distribution of the graphite, which has the appearance of fine small blades and rounded off particles, clearly is shown. The quantity and the size of the graphite particles increases from the outer and inner walls of the pipe toward the center.

The microscopic view shown in Fig. 3 magnified 90 times, was taken about the center of the thickness of the pipe. The same sample after being cleaned and etched with picric acid, Fig. 4, magnified 9 times, shows the normal pearlitic structure of gray pig iron. This structure is extremely fine, but in the internal part of the pipe it becomes modified, and the ferritic structure can be seen only to a slight depth.

Fig. 5 shows the internal portion of the pipe magnified 90 times, and in this white ferrite points and brown phosphorus points may be noticed on a matrix consisting of extremely fine pearlite. Micrograph 6, magnified 9 times, shows the distribution of the phosphorus. This test-piece was etched with nitric acid.

Graphite Is Coarser

Figs. 7 to 11 show micrographs of pipe made in the pit. Figs. 7 and 8, representing the thickness of the pipe magnified 9 and 90 times, respectively, show that the quantity and size of the graphite particles increased toward the central portion of the pipe, the structure of the graphite particles is much coarser than with the centrifugal sand cast pipes. The cleaned sample etched with picric acid, Fig. 9, magnified 9 times, shows a fine pearlitic structure. The same test-piece magnified 90 times, Fig. 10, shows that the white ferrite points are of the same size as in the sample made by the centrifugally sand cast method, on a pearlitic matrix. Fig. 11 is a micrograph of a test-piece etched with nitric acid, and in this can be noticed irregular distribution of the phosphorus, while in this case the white phosphorus points are rather larger than those observed in the sample made by the previous process.

Fig. 12 shows the distribution of the temper carbon throughout the thickness of the pipe in the Arenz centrifugal process, tempered pipe. This sample has been magnified 9 times. It will be noticed that this distribution is uniform in the center as well as throughout the inner and outer surfaces of the pipe. In the vicinity of the outer diameter, almost parallel with the surface, can be seen large nodules of temper carbon.

The central part of the thickness of the pipe, Fig. 13, shows that the distribution of the temper carbon is uniform, but that the size of the nodules is somewhat larger. This sample is magnified 90 times.

On examining the sample after etching with picric acid, as shown in Fig. 14, magnified 9 times, and Fig. 15, magnified 90 times, the ferritic structure may be observed. After etching the sample with nitric acid, Fig. 16, the almost total absence of phosphorus points is noticed which is only to be expected as during prolonged tempering phosphorus enters into solid solution with ferrite.

Chemical analysis of the Arenz tempered pipe gave the following results: Total carbon, 2.76 per cent; temper carbon, 2.30 per cent; combined carbon, 0.46 per cent; silicon, 2.40 per cent; manganese, 0.60 per cent; phosphorus, 0.69 per cent; sulphur, 0.12 per cent.

Micrographs 17 to 21 relate to the De Lavaud process with tempered pipe. Fig. 17, magnified 9 times, showing the thickness of the pipe, and Fig. 18, magnified 90 times, showing the central portion of the thickness, demonstrate that temper carbon is uniformly distributed throughout.

After etching the sample with picric acid, Fig. 19, magnified 9 times, and Fig. 20, magnified 90 times, it is shown that the temper carbon accumulations are in a ferritic matrix, with an admixture of ferrite and sorbite.

When the test-piece has been etched with nitric acid, it is seen that the distribution of the phosphorus, Fig. 21, is not uniform, and in the vicinity of the internal diameter it is more plentiful than at the outer.

Has Good Distribution

These experiments show that the Italian process possesses the advantages of centrifugal casting, namely good distribution of the graphite and of the phosphorus in the form of fine grains, a pearlitic instead of a ferritic structure, apart from the thin film found about the inner diameter of the pipe, which is of no great importance since this ferritic formation may be removed easily by more rapid cooling.

Centrifugal casting in green sand molds has given the following results: Cast iron having a pearlitic matrix and great tensile strength; uniformity in the various thicknesses; reduction of weight as compared with vertically cast pipes; rapidity of production; employment of a moderate amount of capital for the acquisition of the necessary plant; low production costs; rejections reduced to a minimum; minimum quantity of slag inside the pipe, owing to the use of a filtering feed runner and fluid metal and elimination of pipe tempering plant.

Alloy Steel Castings *Meet Demands* of Engineering Development

By J. W. Frank

ALLOY steel castings represent the answer to the demands of engineers and manufacturers for steels of improved quality and strength. By the proper application of alloying elements to steel, it is possible to obtain increased physical properties such as tensile strength, elastic limit, reduction of area, resistance to impact, resistance to abrasion and resistance to oxidation, that could not be obtained from the best of carbon steel castings.

Each of the alloy steels has its own definite characteristics. Due to the increased service, these steels are able to demand a higher price than is asked for ordinary steel castings. By their use, machinery that has multiplied its work power to many times its limit previously set, has been developed.

There are three distinct classes of alloy steels, and their lines of demarcation are clearly marked. First are the steels of high physical properties, such as tensile strength, ductility, resistance to impact, abrasion, distortion and fatigue. The second class includes steels with extraordinary properties, such as resistance to corrosion and magnetic permeability. The third deals with heat resisting alloys. While these are not in the strict sense of the word alloy steels, their growing application in the make-up of heat treating appliances grants them a place and consideration in this discussion.

The first of the alloy steels, both in conception and in application, were the manganese steels. Until recently those having from 1 to 1½ per cent manganese were not classified as alloy steels. Manganese steel of this analysis, when properly heat treated, has excellent tensile strength and ductility, with good resistance to abrasion. It has been extensively used for caterpillar shoes, truck wheels, and in fact, anything requiring higher physical properties at a minimum of expense.

Manganese steel of 12 to 14 per cent content is known universally and has its application clearly defined. It stands alone in respect to hardness and resistance to impact wear. Due to its extreme hardness, it is machined with difficulty, and usually is ground to shape. Where machining cannot be eliminated, soft steel inserts generally are used, being either pressed or cast into the larger castings. Manganese steel also undergoes a plastic flow or deformation, therefore its use is not recommended where wear is due to abrasion. Castings for ball mills, pulverizing machinery and rock crusher jaws illustrate the uses of this high manganese steel.

Alloy Castings Rapidly Gaining Favor

IN VIEW of the increasing production of alloy steel castings, the accompanying discussion of their characteristics is timely. It is abstracted from a paper presented at the thirty-second annual convention of the American Foundrymen's association, Philadelphia, May 14-18, 1928. *The author is chief metallurgist, Chicago Steel Foundry Co., Chicago.*

Alloy steels containing nickel or molybdenum, with manganese somewhat higher than normal, deserve to have a wider acquaintance among manufacturers of steel castings.

Nickel-manganese steel usually contains nickel in the neighborhood of 1 per cent, with 1 to 1½ per cent manganese. The usual carbon range is 0.30 to 0.40 per cent. The use of the nickel obviously adds to its cost, but the increase in ductility and toughness, amply justifies it. This metal also has a higher brinell hardness than the straight manganese steel of low content, under similar heat treatments. It is cast into substantially the same class of work as the 1 to 1½ per cent manganese steel.

In the manganese-molybdenum steels, the manganese is kept within the same limits, with molybdenum 0.20 to 0.40 per cent. The results, as a whole, are the same as with nickel-manganese steel, except that the elastic ratio of the manganese-molybdenum steel is somewhat higher.

Nickel steels are the best known and the oldest of all commercial alloy steels. They were developed primarily for use in armor plate and ordnance, but since the war their peacetime usage has been increased enormously. The nickel range is from ½ to 5 per cent, with carbon 0.10 to 0.60 per cent. Its characteristics are a high tensile strength and elastic limit, with good ductility, fine grained structure, and usually, freedom from blowholes and porosity. These steels are used where extreme toughness is the outstanding requirement. The lower carbon members of this series are invaluable for parts that are to be case hardened. Their use results in a tough core, with a hard case, which is the ideal condition. Bridge castings, rail clamps and car replacers are a few of the numerous uses to which straight nickel steel can be utilized in present day commercial applications.

The nickel-chrome series embraces a comprehensive list. Nickel and chromium complement each other and form ideal combination, having unusually high strength, good ductility, and a remarkable resistance to fatigue and abrasive wear. The analysis ranges from ½ to 3½ per cent nickel and from 0.45 to 1.75 chrome, with carbon from 0.10 to 0.60 per cent. The ideal condition is where the ratio of the nickel to the chrome is in the vicinity of 2 or 2½ to 1. As is true with straight nickel steels, the members of this series having low carbon contents, find application in castings that are subsequently carburized, and are more or less interchangeable with them, but giving a somewhat heavier and harder case.

The medium carbon steels have the widest application and the greatest possibilities. Where abrasive wear is encountered, they are supreme. They are used extensively for caterpillar shoes, chain belt, mill rolls, excavating bucket lips and teeth, oil well machinery, hoisting drums, brake drums, special trackwork, lightweight car wheels, in fact for anything where wear is due to abrasion and not to impact. Brinell hardness is valueless as an index to this resistance, but actual service tests have proven, time and time again that, in this respect these steels are superior to others that are much harder. Evidently brinell hardness has no connection whatever with abrasive resistance. Toughness can be obtained by increasing the alloy content and allowing the carbon to drop to about 0.30 per cent. This metal is very useful for high pressure valves and fittings and for railroad knuckles.

The high nickel-chrome steels, strictly speaking, should not be classified as alloy steels, being really ferrous alloys. The iron is seldom over 60 per cent and may be as low as 20 per cent. This is really an academic distinction, however, and many steel foundries are making castings of this material at present. The ranges of the alloying elements are extremely wide, nickel varying from 20 to 65 per cent, chrome from 7½ per cent to as high as 40 per cent. The silicon may be either normal or anything up to 5 per cent.

If properly made the heat resisting steels are tough, somewhat difficult to machine, and show excellent tensile strengths from room temperature to about 1750 degrees Fahr. There is a gradual loss in strength, but it is not by any means as rapid as is the case with other metals. The feature of these alloys, as their name would indicate, is their remarkable resistance to oxidation. Failures are seldom due to oxidation as often they show no trace of scale after almost indefinite length of service. If care is taken in not overloading them and in not heating or cooling them too rapidly their life will be greatly prolonged.

Heat Resisting Alloy

are cast into annealing pots, carburizing boxes, lead pots, branding irons, oil burners, and heat treating furnace parts, such as linings, chain belts, racks, and similar parts for furnaces used in vitreous enameling. A rather high price differential is paid for such castings, but they prove very economical when heat hours are taken into consideration. In this field especially, intensive advertising is carried on, and without exception, all alloys are marketed under trade names.

Straight chrome steels of low content have been cast but their use is uncommon. Chromium, by itself, gives more hardness than carbon, and at the expense of less ductility. The chromium is usually from 0.60 to 1.50 per cent with carbon usually from 0.15 to over 1.00. These steels, especially those containing the more carbon, are used where rigidity and freedom from distortion are the predominating requirements.

The high chrome steels are the stainless steels and irons. The minimum chromium content is 12 per cent, but some contain as much as 40 per cent. The members of this series that have the lowest carbon are the so-called stainless irons, but they are all made by the same processes, so are really steels. They do not require any heat treatment to bring out the stainless properties, while the stainless steels do. The carbon is seldom over 0.60 per cent.

Recently oil refineries have been heavy buyers of castings of this material for equipment used in the cracking of the crude petroleum oils, which have a corrosive action at high temperatures due to a high sulphur content. Castings also have been made for food handling machinery, both to keep the food products free from contamination and to increase the life of the equipment. As ordinary steel castings have a limited period of usefulness in the handling of acids and caustic alkalies, chemical industries have been using increasing quantities in the form of agitator arms, kettles, pipe lines, driers and other parts. The irons have the maximum resistance to corrosion, but are only moderately hard. The stainless steels are also said to take and retain a better polish.

Nickel and nickel-chrome steels were so enthusiastically received by industry in general that investigators were encouraged to study other elements as potential alloys. The most successful of these are the molybdenum and vanadium steels and combinations with elements mentioned previously.

Straight molybdenum steel is not common in castings at present. The molybdenum is usually 0.20 to 0.40 per cent but may be as high as 0.80. The main advantage in using this metal is the relative ease in welding it to other parts in fabricating.

Molybdenum in conjunction with chromium produces a steel, the use of which is increasing by leaps and bounds. The uncertainty of results that has been troublesome in the past, has been entirely eliminated with improved methods of adding the molybdenum. The outstanding effect of the molybdenum is the unusually high elastic ratio, with high tensile strength and good ductility. The advantage of this steel over chrome-nickel is the ease with which it can

Use Discrimination in Buying Steel Castings

ALLOY steel castings require more care in manufacture, than do castings of plain carbon steel. As cast they are hard and brittle, and unless properly annealed, are apt to remain so. In general, the cast structure is harder to break up, and at the same time it is most essential that this be done. They require a longer annealing at a higher temperature, as a rule. Care must be taken, if surface welding is necessary that such parts be reannealed, as otherwise hard spots are sure to be found on machining.

The real benefits of the alloy additions are not brought out unless the castings undergo a heat treatment. A simple air quench from annealing temperature, followed by a draw at a comparatively high temperature, often accomplishes wonders, as compared to the results obtained by a straight anneal.

Alloy steels cannot be considered a panacea for all the troubles that arise in the use of steel castings. Neither must the user place the blame for isolated poor results, on the contained alloys. The user must use the same discrimination in judging results, that he uses in his judgment of ordinary steel castings, as well as other products.

Alloy steels have come to stay. The steel foundryman must be constantly on the alert to improve quality, and to take advantage of improvements when they arise, so that he will be able to get his share of this large and constantly increasing business.

be machined. In actual practice it has been shown that, at the same brinell hardness, a considerable saving can be made in the average time of each machine shop operation. The drawing temperatures of this steel are unusually high and it is less susceptible to overheating. Molybdenum is almost always kept within 0.20 to 0.40 and chrome 0.70 to 1.10 per cent. Carbon is usually 0.20 to 1.00 for the general run of work. Steel of this analysis is especially tough and has been used with success in blooming mill rolls. If the carbon is allowed to rise above this figure to almost 2.00 the rolls are extremely hard and rigid, and have excellent resistance to abrasion.

The addition of molybdenum to a nickel-chrome steel results in a metal that should be of particular interest to foundrymen. It retains all of the good qualities of the nickel and the chrome, the ease of machining of the chrome-molybdenum steel, and, in addition, has the peculiar characteristic of hardening almost as hard by air quenching as if a liquid medium were used. It is the solution, in large castings, or castings, the nature of which makes water or even oil quenching precarious. Distortion can be kept at a minimum, internal strains lessened, fire cracks eliminated, and the cost of the heat treatment appreciably lowered. Quite a bit of the finish can be pared off the patterns, thus saving additional time and expense in machining. This makes nickel-chrome molybdenum steel the ideal metal for cast die blocks. These are steadily displacing forgings, due to the heavy expense of sinking the die into a solid block. They can also be resunk very cheaply, as they can be remachined without annealing. With low carbon, at or nearly 0.30 and higher nickel and chrome, a steel of very high ductility and elastic limit is obtained. It is highly recommended for high pressure fittings, for railroad knuckles, and where great strength is necessary.

Castings of chrome-vanadium steel have been made for some time, and vanadium steel specifications are always "minimum 0.15, 0.18 desired," chrome 0.80 to 1.10. It also has high tensile strength and good ductility, but its characteristic is its resistance to fatigue. Since the steam locomotive has had its power and weight increased, many frames and other massive parts have been made in alloy steels.

Englishman Discusses Gray Iron

THE first meeting of the 1928-29 season of the London branch of the Institute of British Foundrymen was held in the Engineers' club, Thursday, Sept. 20. J. E. Hurst in presenting a paper on "Gray Cast Iron," stated that with such a wide subject it was necessary to limit his observations to one or two special aspects. He chose to discuss the principal formulae and diagrams that are used with a view to finding the correct composition for obtaining castings of certain qualities.

The well-known formula

$$Sc = \frac{C}{4.26 - \frac{Si}{3.6}}$$

was discussed first. In the speaker's opinion, this formula is somewhat fallacious. It really amounts to calculating the summation of total carbon plus silicon to obtain a casting of a certain fracture, and it takes no account of such elements as manganese, sulphur, phosphorus, nor conditions such as melting temperature and rate of cooling. Mr. Hurst believes that it would be more practical in most cases to have a list of well-known compositions which correspond to the required fractures.

The speaker then discussed the Maurer diagram. This diagram is an improvement on the preceding formula, because it takes account of the thickness of the casting. However, in view of the fact that the diagram is composed of straight lines it is aparent that it is really too simple, and it is open to the same criticisms as the formula, because it only takes account of the summation (total carbon plus silicon). An example was given of two compositions of iron, one containing manganese and the other having only traces of manganese, the fractures of which did not correspond to the fracture which is indicated in those cases by the Maurer diagram. An improved diagram is that of Gleiner and Klingenstein, which does take account of the rate of cooling, and has been established under conditions where the minimum percentage of total carbon is 2 per cent and the maximum casting temperature is 1450 degrees Cent.

However, Mr. Hurst pointed out that in all these formulae and diagrams the results were obtained in relation to the total carbon plus silicon summation, and he considers this to be a great defect. For that reason he prefers the Thrasher diagram, which gives the results in relation to the composition in silicon and carbon separately, and which also takes account of the thickness of the casting. While admitting that these diagrams in many cases are useful and give a sufficient indication of the composition of cast iron to be adopted, Mr. Hurst pointed out that it now is recognized universally that castings made with exactly the same chemical composition do not possess the same physical properties, since in the process of casting there are such conditions as melting temperature, rate of cooling, impurities, and perhaps unknown factors that influence the final qualities of the casting. In cases where the specifications are severe, such diagrams as those discussed are not sufficiently accurate to be of great use, and an example was given in the manufacture of piston rings. Two rings were cast with metal coming from the same ladle and under the same conditions. The rings were of equal thickness, and the only difference was in the diameter. However, in testing these rings for elasticity and tensile strength, the smaller ring gave results which were acceptable according to the specification, which, incidentally, were extremely severe; but the ring of larger diameter was rejected.

Wesley Lambert opened the discussion and stated that several years ago he had used formulae which did take account of manganese, phosphorus, and even sulphur. It is of interest to note that in nonferrous metal practice there are formulae which, although complicated, can be adopted with a certain degree of accuracy, but it seems that the problem is much more complicated with respect to gray cast iron. Referring to Mr. Hurst's example of the two piston rings, Mr. Lambert suggested that there might be a question of internal stresses, but Mr. Hurst asserted that special tests previously were made which showed that there were no internal stresses, and, furthermore, the difference in the diameter of the two rings was not enormous, one ring being 3 and the other 4 inches. V. C. Faulkner mentioned that there exists a long list giving a considerable number of compositions for all kinds of given castings, and that this has been found extremely valuable.

Charles Vickers Says—

Deoxidizers Should Be Used Discreetly

This Is Number Three of a Series of Articles on Practical Brass Founding

WHILE the drossing effect produced by the action of small amounts of silicon in copper castings is not to be compared with the similar action produced by aluminum in nonferrous alloys, it is sufficiently serious to require precautions against its formation and entry into the molds. Thus, if a deep mold should be gated on the top so that the metal dropped and splashed when filling it, dross would be formed by the breaking of the surface films, which are formed instantaneously and coat the falling stream of metal as well as each little splash and droplet that broke away.

When the film enveloped stream of metal breaks apart the liquid interior flows out, leaving behind a husk of film. These husks get squeezed against the sides of the mold. When the casting is uncovered it is generally found they have formed as laminations and can be picked away from the casting in the form of slivers, with a knife blade. This form of dross renders it impossible to machine the surface of the casting and get down to good, clean metal without taking off too much stock. Consequently the casting has to be scrapped.

Gates Attached Low

This trouble is avoided to great extent by locating the gates at the lowest point of the mold. Gating at the bottom, in the language of the molder. The same precautions are required against undue agitation of the metal, such as bounding back from impact against the sand walls of the mold or core, and collisions between entering streams, as are necessary with aluminum bronze and other aluminized alloys. Also, in casting sticks, bushings, strips or other long pieces, it is always advisable to so locate the gates that the molten metal climbs a hill to fill the mold and then flows into a riser.

Fig. 1 shows a method of molding a heavy copper disk, or a heavy bar of copper. The casting is supposed to have been poured, then allowed to cool, and afterward slit through the center longitudinally. Of course, this only happened in imagination and it is represented in this manner to show the method of molding better. The copper was deoxidized by 1 per cent silicon. This causes a certain amount of drossing of the copper, which in the casting illustrated was avoided by pouring with the sprue at a point that can be made the lowest point by tilting the flask. The riser is located at a point diametrically opposite the sprue in a disk, and at the high end of the mold in a strip or bushing.

When the molten metal enters the mold cavity through the gate attached to the sprue, it collects and forms a pool gradually increasing in size as the metal continues to flow. This pool spreads and rises until it fills the mold. Without causing any particular commotion, it next fills the riser as high as the sprue can fill it. A considerable part of the riser though is empty, and if the riser is to perform the work for which it was put there, solidification must be retarded until the casting has set. In all cases a riser put on a casting for feeding purposes, must set after the casting, or it is absolutely worthless, and a waste of metal.

Copper Shrinks Heavily

Well deoxidized copper shrinks heavily and if the disk is not fed liquid metal to fill up the voids caused by shrinkage, the central portion of the casting will be in a *pappy* condition after solidification, and a depression or *shrink* also might present itself. Therefore, a riser is placed on the highest point of the casting to supply surplus metal for feeding. As the mold now stands, this riser is filled partially with the coolest metal poured; metal that has been pushed through the entire mold by the hydrostatic pressure of the sprue. This metal cannot be expected to do the required feeding as it has lost much of its fluidity. It has to be reheated by pouring some hot feeding metal into the empty part of the riser. As the riser is higher than the sprue, it cannot be filled while the sprue remains open. Either the sprue has to be solidified, or it has to be plugged. As a general rule it is best to plug it and this is done quickly as shown in the sketch by first covering the metal with molding sand and then bedding a weight to counteract the pressure of the metal as the riser is filled.

Metal that is poured into the riser should be hotter than that used to pour the casting and it should be poured slowly so that in a measure, it may keep pace with the cooling of the casting. When feeding thick sections by this method it is often advisable to begin pouring into the riser before the sprue is dammed by the weight so that a few pounds of metal can overflow, thus opening up

Appreciates Articles

RECENTLY Robert C. Hopkins, known widely throughout Ohio and adjoining states for his interest in foundry affairs, expressed this opinion of the articles by Mr. Vickers one of which appears on this page. He says:

This is of real value to the foundryman, and this we know for a fact. Mr. Vickers and this company have been in close touch for the last ten years. I do not know of a man who brings more honest endeavor and sincerity of purpose to the work than does Charles Vickers. He is a man equipped, both technically and by experience, to do just these things; it is his chief interest and ambition to be useful and active in solving the problems of the brass foundry.

Mr. Hopkins is president of the Alliance Brass & Bronze Co., Alliance, O.

a channel of communication between the riser and the heart of the casting. When this is thought advisable the head of the sprue should be shaped to form a flow-off, and provision should be made for catching the overflow metal.

Forms Films On Copper

The film forming property of silicon seems to be confined mainly to copper and to yellow brass. It is not sufficiently pronounced to cause much trouble in alloys of copper and silicon, in which this latter element may be present to a considerable amount. Silicon in nonferrous alloys was discussed by the author in an article in THE FOUNDRY, April 1911, pages 264-267. The chief advantages of the film lie in the protection against oxidation in the molten copper as it is being conveyed to the molds for pouring. Due to trouble from floating particles of dirt getting into the molds, many foundrymen insist upon skimming all their metals clean before they are carried off. It is bad practice, especially with copper.

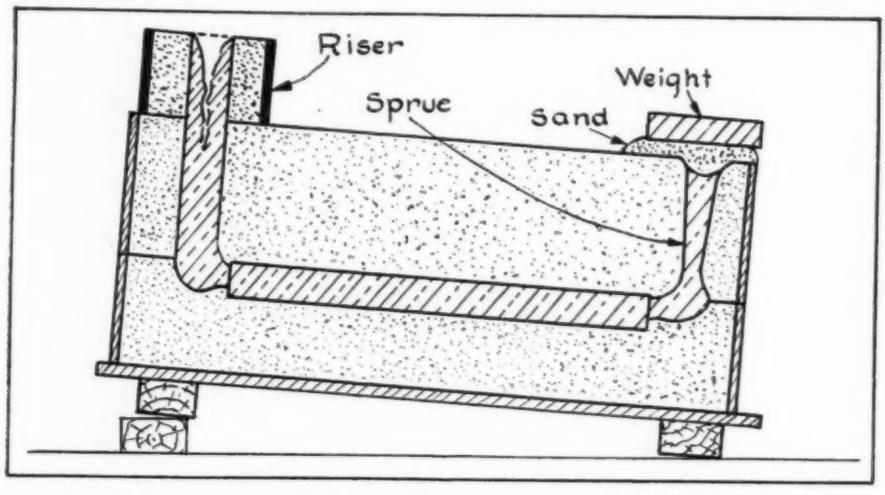


FIG. 1—LONGITUDINAL SECTION THROUGH CENTER OF MOLD AND COPPER DISK CASTING

Copper castings made with silicon as the deoxidizer are not *high conductivity* copper but mechanical copper castings. In earlier days they were tne best that could be made and were used largely for electrical work, where now they would not be considered. Silicon is a low cost deoxidizer, and for that reason still is used considerably in making copper castings. In pressure-resisting castings, there is danger of loss by leakage, due to folding in of surface films. Consequently, the usefulness of silicon is limited in two directions: For high conductivity, electrical castings and for low conductivity pressure resisting copper castings.

Addition of calcium to the silicon helps conductivity materially, but not the pressure resistance. Calcium does not entirely suppress the formation of films over the surface of the copper.

No important conclusions on the effect of chromium on the conductivity of copper can be drawn from Barclay's table presented in the first artile of this series. This table states that 0.04 per cent chromium reduces the conductivity of copper 8.5 per cent. This amount of chromium is insufficient to deoxidize copper. In fact many times that amount has no effect in the direction of promoting sound copper castings.

Made Extensive Tests

This statement is not made at random, but as the result of an extensive series of tests with chromium as a deoxidizer of copper, carried out by the author. The work was done to discover if chromium held promise as a deoxidizer for making copper castings in sand molds and the results showed a decided negative. These were not chill castings of copper, but were sand molded castings made commercially. The initial experiment consisted in melting 9900 grams of electrolytic copper in a plumbago crucible under charcoal and when properly liquid 100 grams of a supposedly 10 per cent alloy of copper and chromium was added. The castings were porous, badly so, but one thing was learned. That thing was that chromium gave a clean appearance to sand cast copper. There were no *films* to fold in, or any defects of surface. The color of the skin was a dull reddish-brown, pleasing to the eye.

Eventually chromium proved a failure, for when the amount was increased other difficulties appeared and its use as a deoxidizer of copper had to be abandoned. When mixed with other elements it was more successful. However, it was a problem to alloy it to make a homogeneous deoxidizing alloy for copper with elements with which it would combine to work harmoniously. When these substances were melted together the result was only a slag. The metals had to be mixed mechanically, and while excellent results were obtained in making high conductivity castings in sand, the use of this element as a deoxidizer had to be abandoned after several months' tests.

Chromium ought to prove an efficient deoxidizer, for the heat of formation of the oxide Cr_2O_3 is in excess of 240,000 calories, while that of cuprous oxide is only 43,800 calories. However, this fact means little for there are numerous elements having high heats of formation of their oxides as compared to that of cuprous oxide. Many of these are absolutely worthless, even harmful when used as deoxidizers, so called, to produce castings of copper in a sand mold.

Doubt Exists

There appears to be some doubt as to the extent to which copper and chromium will alloy, and the literature on that subject is scanty. The 10 per cent chromium-copper previously mentioned was not analyzed as it should have been, so it is doubtful if it contained anywhere near the 10 per cent chromium with which it was credited. The amount of chromium used in copper was increased progressively from 1 to 25 per cent without any hopeful results. Castings treated with 1 per cent had the best appearance but were unsound. These experiences with chromium are related to serve in a small way as a guide to those who may at some future time undertake an investigation into the effects of chromium as a deoxidizer of copper for making high conductivity castings. They may be regarded as the practical findings of an experienced foundryman.

Phosphorus is used extensively as a deoxidizer of copper but it has a depressing influence upon its electrical conductivity and for such castings it should not be tolerated. The addition of 0.5 per cent of 15 per cent phosphor-copper reduces the conductivity of the copper about 37 per cent. Few foundrymen are able to make sound copper castings by the addition of this amount of phosphorus. Usually it is necessary to add 1 per cent of phosphor copper. Not unfrequently more than this amount has to be used and 1.5 per cent may be found necessary.

By careful melting of the copper in a crucible possibly 0.5 per cent of phosphor-copper may be sufficient to produce sound copper castings, but from the viewpoint of the electrical

engineer, those castings are worthless, because of reasons given before in these articles. The foundryman who imagines he can make high conductivity copper castings by the use of phosphorus, is mistaken, although he may be perfectly sincere in his belief. It is true that cast copper deoxidized by phosphorus *looks* good. It is undoubtedly high in copper, but it has been poisoned and its conductivity destroyed. In spite of this fact many tons of copper castings deoxidized by phosphorus have been made and sold as *high conductivity* castings. Foundrymen producing them implicitly believe they are such, and this belief seems to be amply fortified by the fact that they have *got away with it* for so many years. They have been successful simply because the castings never have been subjected to the proper tests. The purchaser has taken the conductivity for granted, or, the castings have been put into service where brass or bronze would have been just as good as far as electrical properties were concerned, and much better in physical properties.

Blast Furnace Castings

For copper castings where conductivity is immaterial, phosphorus is an efficient deoxidizer. For many castings used in connection with blast furnaces, phosphorus works well, and from 1.00 to 1.50 per cent phosphor copper is the amount generally used. For copper terminals and such castings used on electric furnaces, the high conductivity deoxidizers are most suitable, although this depends largely on the massiveness of the castings compared to the current they must carry. Usually they are designed by engineers who do not intend to use 2 pounds of copper where 1 pound ought to be ample.

Effect of phosphorus on copper alloys is well known to all brass foundrymen. The metal is characterized by great fluidity. While it flows well into the molds and will take the finest impressions, it also will eat into the sand of mold and core, and produce exceedingly rough castings if poured too hot. In this respect it acts somewhat like water. If water was poured into a sand mold, it would seep through the sand and flow away under the bottom board and through all other openings impervious to metal. Phosphorized alloys are a long way from being like water as far as flowing and seeking their own level are concerned, and it is a fine provision of nature that they are, otherwise they could not be cast. However, they are liquid, and the liquidity increases when the copper is alloyed. In casting tuyeres, the copper containing from 1.00 to 1.5 per cent of phosphor-copper, or from 0.15 to 0.225 per cent phosphorus, can be poured at a temperature of around 2200 degrees Fahr. The metal will not cut excessively into the sand of the mold, but it may form burrs in the cores if they are not protected by a coating of plumbago. *If* a bronze containing the same amount of phosphorus is poured at the same temperature it will be likely to cut into the sand considerably, and a yellow brass would be much worse.

Resembles Silicon

Phosphorus resembles silicon in one way and that is, that the less left behind in the copper, the higher will be its conductivity. If the molten copper should be *poled* or otherwise treated to reduce its oxygen content,

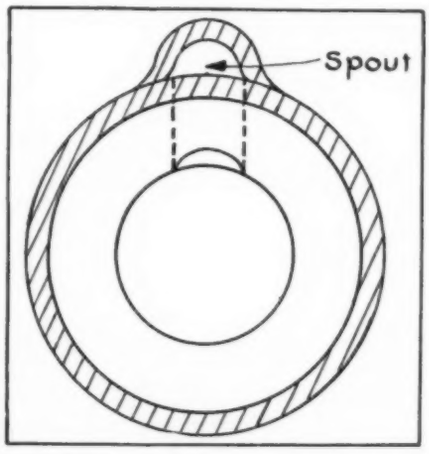


FIG. 2—TOP VIEW OF BOTTOM POUR LADLE

less phosphorus can be used to deoxidize, and less will be left behind to affect conductivity. Also, when an abundance of phosphorus is used to deoxidize, if the excess is removed before the copper is cast, the copper will possess high conductivity, exactly the same as with silicon, for what is sauce for the goose is sauce for the gander.

The question then arises, which of the two deoxidizers is the better. This is something for the future to decide. After the work of deoxidation has been accomplished, removal of excess phosphorus is a simple problem in nonferrous metallurgy, one the metallurgist loves to tackle on a cool evening after his pipe has been lighted. We will leave it that way, not wishing to spoil any person's pleasure.

When copper has been melted in an open flame furnace, no matter what deoxidizer is to be used, more will be required when the metal is skimmed clean while in the furnace. With phosphor-copper 1.5 per cent will be required, added half in the furnace and half in the ladle. If the copper is not skimmed in the furnace, 1 per cent of phosphor-copper is enough. Those who are sceptical in regard to this simple statement can try it, and see for themselves.

When molten copper in the furnace is clothed with a slag, it changes slowly compared with its change when naked under the same circumstances. The furnace gases are as hot as the copper and the interior of the furnace, and they are greedily absorbed by the copper compared to the absorption of atmospheric gases when the copper is skimmed outside the furnace. It follows that the careful melter will see that the copper is covered all the time it is in the furnace.

In *carrying off* the copper, that is transferring it to the molds, it is advisable to keep it covered with charcoal. The trouble is that it is not always practical to do this as the floating bits of charcoal have an uncanny way of evading the skimmer and getting into the mold and thus creating scrap or wasters.

Much crudity attends the pouring of metal in brass foundries as a usual thing. The skimmer will be a length of flat wrought iron bent to a crook on the fire end, and sometimes it consists of a length of simple round bar without any crook. If the metal is not skimmed pretty clean the dirt cannot be held back with such tools and some enters the molds. In such cases it is safer to skim the pot or ladle before reaching the molds. While most founders realize that some metals ought to be kept under cover, the problem is to solve the difficulty of doing this, and at the same time get clean castings.

Metal Cools Rapidly

The time element also is a big factor in the problem. Metal once out of the furnace has to be put into the molds without delay as it cools rapidly. Joseph McGinnis, a practical foundryman of Syracuse, N. Y., stated to the author that tests he had conducted gave the rate of cooling as 10 degrees Fahr., per mold poured. This is with ordinary foundry conditions and it shows that molten metal has to progress continually until the vessel is empty. There is no time allowable for experimentation. In steel foundries and some iron foundries, bottom poured ladles are used. These are out of the question in a brass foundry. One reason is that the comparatively small amount of metal handled would make such ladles too expensive. Another reason is found in the manner in which nonferrous metals oxidize when poured. They leave strings of surface-oxidized metal hanging from the lip of the pouring

(*Concluded on Page* 859)

EFFECTS SAVINGS
in Production of
Heavy Gray Iron Castings

By E. C. Kreutzberg

ONE of the features which attracted attention at the foundry show in Philadelphia last May was an exhibit of castings produced at the plant of William Sellers & Co. Inc., Philadelphia. The castings were of gray iron and semisteel, the latter containing from 10 to 50 per cent steel. Surfaces of the castings were smooth and free from even minute blemishes. Unusual strength, exceptional machineability, and perfect workmanship were combined in the castings.

When William Sellers & Co. was organized in 1843, quality was the foundation upon which the business was built and since that time this ideal has been carried out in the foundry as well as in all other departments of the company. A wide variety of machine tools, large and small, are manufactured. Castings for these tools range from exceptionally small pieces up to planer and boring mill castings weighing 90,000 pounds.

The art of casting at William Sellers & Co. has been developed continuously on the basis of experience, supplemented by the initiative of men in charge of foundry work. The last 6 years cover a period of rapid development. This development not only has improved the quality of castings produced at the plant, but has placed foundry operations on a high efficiency basis. Independent studies of the sand and iron problems and an endeavor to conserve foundry floor space has resulted in numerous changes. The plant is located in a built up section in the heart of Philadelphia where space is at a premium and the successful efforts to conserve this space have been valuable.

Statistics showing the percentage of castings lost due to defects, reflects an amazing improvement at the Sellers foundry over the past few years. Figures are as follows: In 1923 the loss due to defects, was 5¾ per cent. This loss has been reduced gradually until, during the first half of 1928, the loss was about 2 per cent. This large reduction in the loss due to defects results pri-

FIG. 1—SAND IS FED INTO THE FLASK ON THE MOLDING MACHINE FROM CHUTES. THE SAND IS CARRIED TO THE CHUTES ON BELT CONVEYORS

marily from changes in the sand system and in the analysis of the iron.

Where the company formerly employed eight to ten different sand mixtures, it now uses four. An inefficient sand mixing and handling system was supplanted with simple but effective equipment. The proportion of burned sand in its mixtures was increased greatly, with a corresponding cut in the cost of new sand. The cost of sand for a ton of good castings a few years ago ranged from $1.93 to $2.95, while the cost now averages $1.25 for a ton of good castings. In addition to having the lowest defective castings loss in its history, and the lowest sand cost, the surface condition, strength and machineability of the castings now are far superior to the castings which formerly were made.

Experience of this company with an intricate sand handling equipment of its own design and manufacture, was such that the management has been careful since the equipment was operated to have all physical units of its system as simple as possible. The cost of maintaining the old complicated system was so high that it had to be eliminated.

Sand equipment gives economical results in mixing both facing and core sand. Any inclination toward lumpiness of the sand is corrected by passing the sand through a screen thus breaking up the lumps. At present air operated sieves are employed. Because these sieves require extra labor, a centrifugal sand mixer made by the Sellers company now is being adapted for use with the muller type machine. The sand coming from the sand mixer will pass through the centrifugal machine. This will eliminate the necessity for sieving the sand and at the same time will aerate the sand before it is used.

To conserve floor space, practically all of the sand system is elevated. Sand is received in box cars and is unloaded into elevated bins in the foundry. The plant has one gravel bin with capacity for five cars, one Lumberton sand bin with capacity for five cars and one sharp sand bin with capacity for two cars. Formerly, when more sand per ton of good castings was consumed than at present, a greater amount of space was required for sand storage. The sand mixer is located immediately alongside the row of bins. This mixer also is elevated and hence takes up no floor space. Mixed sand is dropped into 2½-ton buckets in which the sand is transported, by cranes, to any part of the plant where needed. The sand mixing system is operated by one man.

The management of the Sellers foundry does not feel that it must meet the same conditions that confront the foundryman who is concerned with mass production. The system in this foundry comes nearer being a unit system, which accounts for certain details of practice which differ from the practice at quantity production shops. While simple sand handling equipment is used throughout most of its core and molding

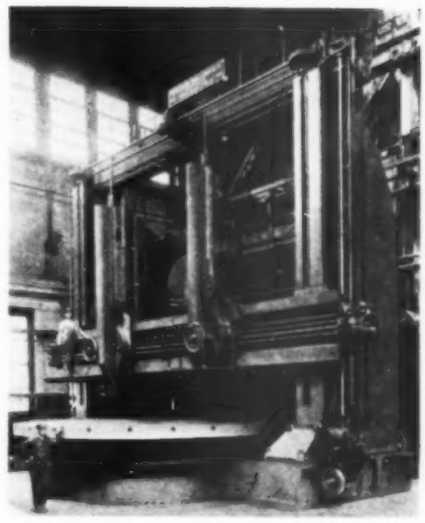


FIG. 4—SOME ESPECIALLY LARGE CASTINGS ARE MADE IN THE FOUNDRY

units, an exception is noted in the handling system of one of its machine molding departments. This equipment is similar to that used in production work. The sand is brought to that department in a bucket, and is dropped into the boot of an electrically operated conveyor. This conveyor elevates the sand and delivers it to chutes immediately above the molding machines. Elsewhere throughout the foundry and

Fig. 2—(Left) Method of Weighting Large Mold for Planer Bed Casting. Fig. 3—(Above) Standard Flasks Are Used for Work Made on a Roll-Over, Jar Ram, Pattern Draw Molding Machine

core shops, the sand is carried in buckets and dumped either on the floor or into bins. It is withdrawn from the bins by hand as required.

Four different sand mixtures are used. Heavy facing for large work consists of 33⅓ per cent new gravel and 66 2/3 per cent burned coarse

sand from the large workshop, no sea coal being used. If an exceptionally strong facing is required a pint of molasses to 14 quarts of water is mixed through the batch while it is being prepared.

To avoid an excess amount of clay in the molding sand, the foundry uses as much old sand as possible. The old sand is well burned and carries a considerable amount of fine cinders from the cores. These cinders increase the permeability of the sand. By using old sand extensively, the company obtains in its gravel mixtures a strong open sand which dries thoroughly and quickly and is sufficiently open to enable the gases generated on the surface of the mold to get away quickly and freely.

One feature against which provision has to be made in making molds from mixtures containing a large proportion of burned sand is the rapidity with which the mold dries. Formerly it was the custom to ram up a mold and then finish it. Due to the sand drying rapidly, it now is necessary for the molders to finish as they go along. For example, with long planer or lathe beds it is customary to complete about 12 feet of the mold at a time, until the entire mold is finished.

Facing for small hand and small machine molding comprises 85 per cent used sand and 15 per cent strong Lumberton of medium coarseness. This sand has to be strong, because the minimum amount of securing is done on the small machines.

It has been found that a properly mixed gravel core, such as previously mentioned, is sufficiently strong for the company's purposes. Some of the cores made from the mixture are 8 feet high, 5 feet wide and 4 feet 6 inches thick and well cut up on the bottom by 8-inch reinforcing ribs. Some of these cores weigh approximately 15,000 pounds when ready to place in the mold, the core arbors and rigging accounting for a part of the weight. The addition of molasses, as described, makes it possible to meet any condition where an extra strong core is desired.

After some experimental work, the company discontinued the use of sea coal. It was found the holes appeared when sea coal was used and that they did not show when that material was not used. Small particles of clay in the facing sand used on green sand work will cause imperfections since steam is generated when molten iron comes in contact with the little balls of wet clay. For that reason the sand is mixed thoroughly.

Until recently the company used a special compound for gravel core mixtures but it found that the binder was most effective when least needed. At core oven drying temperatures of 450 to 600 degrees Fahr., the heat was not sufficient to melt the compound back of the surface of the core. Hence, the binder in the interior did not function until the core was surrounded by molten iron.

The company uses vent wire at different points in the mold. All of the bottom flat surfaces are vented with a ⅜-inch wire, the wire being used freely 4 to 6 feet from the gates on each end. The side walls are treated in the same way for several feet around the gate and within 2 inches of the face of the mold. During the drying of the molds, which is accomplished by charcoal briquettes hung in salamanders, the steam escapes. When the molds are poured the gases escape through the dry open sand and through the vent holes. Carbon blacking is used as a wet blacking for cores and dry sand molds, while plumbago is used for facing green sand molds.

Oil sand mixtures are made in the ratio of 50 to one. The company uses a great many large oil sand cores in its large work and thus saves time in cleaning. The oil sand cores produce a sharp, smooth inside surface in the castings. The oil sand cores also are safe to use when the casting is so designed that it is difficult to take the vents off the cores. A special mixture of oil sand which gives good results in the Sellers foundry consists of three parts sharp sand and one part Lumberton sand, strong and of medium coarseness. This also is mixed 50 to one. It produces a green binder which aids in making cores which would be difficult to make in straight sharp sand. The company also has found the use of the Lumberton sand helps to decrease the slag in high cores.

Initially, some difficulty was encountered with the oil sand mixtures, in getting the oil to mix with sand having a clay content. This trouble has been overcome by using an oil specially compounded for that purpose. This oil dries rapidly and makes strong cores. In all of the cores, the company uses plenty of dry cinders, made from burning rice coal. The use of cinders not only gives a well ventilated core but aids the drying. Cinders also weaken the structure of the core so that when used in light castings the cores will crush under the force of contraction of the iron.

An important feature of the sand system is a sand pit located in the cleaning department. This pit is 30 feet long, 10 feet wide, and 6 feet deep. It is covered by steel wire screen of ½-inch mesh which rests on a grating of ½ x 3-inch steel bars which are spaced 3 inches apart and are supported in the brick side walls of the pit. Cores are cleaned from large castings on top of this pit and the sand is sieved as it passes through the screen. When sand is needed for the mixer, the screen is taken off in 6-foot sections. The sand is removed

A P. LEE has come into prominence as a foundry executive through his progressive work with William Sellers & Co. Inc., Philadelphia. Mr. Lee has spent his entire working career in the foundry business. He was born in Chelsea, Mass., in 1885, and was educated in the schools of that city. He served his time with the Perkins Machine Co., Warren, Mass., becoming familiar with the foundry and other departments of that company's plant. In 1908 he became foundry foreman, Standard Foundry, Worcester, Mass. In 1910, Mr. Lee became foreman of No. 2 foundry of the Baldwin Locomotive Works, Eddystone, Pa., and later became foundry superintendent at Eddystone. In 1917 he was made foundry superintendent for the Pusey & Jones Co., Wilmington, Del. In 1918 he joined the Sun Shipbuilding & Dry Dock Co., Chester, Pa., as foundry superintendent, and in 1922 assumed his present connection as foundry superintendent for William Sellers & Co. Inc. Mr. Lee has traveled extensively, visiting many foundries in this country and in Europe.

in buckets and is transported to the sand mixer where it is used in heavy facing and core sand mixtures.

Important savings are effected by the use of this bin. It has resulted in a vast saving in the amount of space which was required for cleaning castings. It has resulted in saving the labor of four men in the reclamation of sand. The cleaning room gang has been reduced from six to two men while the same amount of work is accomplished.

The time required for cleaning large castings also is reduced by using the pit. The fact that the sand drops through the screen and the men do not have to stand in hot sand is another advantage. A great saving in floor space, a reduction of 2/3 in the amount of cleaning shop labor, quicker delivery of castings to the machine shop, and prompt vacating of the foundry floor so that it is ready for new work, are the advantages obtained by the use of this sand pit. At the present time a magnet is being installed which will remove small pieces of iron intercepted by this screen. These now are removed by hand.

FIG. 6—PIT WHERE THE BURNED CORE SAND IS REMOVED FROM THE CASTINGS

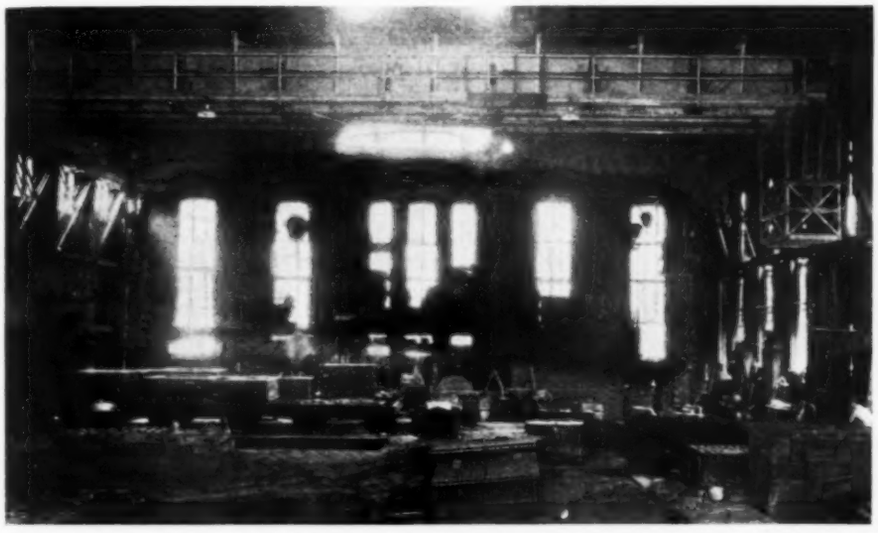


FIG. 5—THE FOUNDRY IS EQUIPPED WITH TWO 40-TON CRANES TO HANDLE THE HEAVY WORK

The practice of employing covering plates instead of copes for large work has resulted in considerable saving in broken flasks and flask labor. Plates are made in various sizes up to 10 x 15 feet and are similar to plates used in loam works. They have a rail cast around the outside which is used for striking off the sand after plate is rammed. Handy men make these plates up and finish them ready for drying.

The Sellers Co. uses a brick gate for large castings. This gate was designed to keep all possible dirt out the casting. Sand gates through which a large amount of molten metal flows naturally cut some and the sand goes into casting. When a mold is dried in the ground, difficulty is encountered in thoroughly drying the gates since steam is driven to the gates.

Important changes in the company's foundry practice also resulted from a study of the iron. The present iron practice is based on the principle that high phosphorus content is not needed for so-called long-life molten iron, and that low phosphorus and high manganese give an iron of much better quality for work made by the Sellers company than iron with these elements normal. Iron also is melted at high temperatures.

For gray iron castings, the analyses range as follows:

Phosphorus	under 0.25 per cent
Manganese	about 0.75 per cent
Sulphur	about 0.08 to 0.10 per cent
Silicon	1.2 to 2 per cent
Chromium	0.0 to 2.00 per cent
Nickel	0.0 to 2.00 per cent
Total carbon	3.00 to 3.40 per cent

Much of the commercial output of this foundry is semisteel, carrying

FIG. 7—MACHINE SHOP SHOWING SEVERAL OF THE HEAVY CASTINGS IN THE PROCESS OF ASSEMBLY

from 10 to 50 per cent steel. To make semisteel, the company adds rails or other suitable steel scrap to the base mixture. The principal resulting change in analysis is lower carbon, the graphitic carbon content growing less and the combined carbon greater as the percentage of steel addition increases.

The company prefers to produce proper mixtures of iron direct from the cupola without any ladle additions. Experiments conducted at that plant have shown that in some cases when ladle additions of ferrosilicon, ferromanganese, titanium, vanadium nickel and chromium are made, different conditions may be found in different parts of the same casting. Because of the results of these experiments the company decided to use pig iron containing nickel and chromium in addition to regular foundry iron. To increase the silicon in the mixtures, the company uses silvery iron ranging from 9 to 11 per cent silicon, but with other elements running normal.

Use Various Alloys

In its attempts in the direction of strong iron, the company has proceeded from the standpoint that the strength increases as the total carbon is decreased and the graphitic carbon reduced, thus obtaining closer grained iron. It has used up to 98 per cent steel scrap in these strong iron mixtures, the remainder of the metal comprising the contents of alloys resulting from the addition of ferrosilicon and ferromanganese, or ferromanganese and nickel. The iron that was obtained was strong, close-grained and readily machinable.

Many of the company's castings, both gray iron and semisteel, are cast in chill molds or permanent molds. Iron containing not more than 0.50 per cent manganese, less than 0.25 phosphorus, as little sulphur as possible and 1.8 to 2.2 per cent silicon when cast in chill molds, possesses all the requisite qualities, including exceptional machineability. To secure better machineability, nickel may be added, and the silicon content lowered.

Much satisfaction has been derived at this plant from a sweeping change in the flask equipment used to produce large unit work. A much smaller amount of equipment now is required for the same volume of work, and less floor space is used for the storage of flasks. Further, the loss by breakage has been reduced greatly. Formerly the company made flask pieces up to 120 inches long, and the breakage of these pieces was an important item in the cost of operating the foundry. Now the company has a standard unit system whereby parts permit the assembly of a flask in any size desired. These parts are machined on the ends and flanges and are interchangeable. Their size may be read at a glance, being indicated by the number of bolt holes. The full assortment of sizes of these flask parts is as follows:

Height in inches	Length in inches
50	10 12 14 16 18 20
40	10 12 14 16 18 20
30	10 12 14 16 18 20
20	10 12 14 16 18 20
10	10 12 14 16 18 20

With this knock-down rigging, the company may make flasks to within 10 inches of any desired size.

The flask parts are semisteel castings which are molded on a jar ram rollover molding machine. Three or more pieces, depending on the size, may be made in the cope and three or more may be made at the same time in the drag, a splitting core dividing the cope and the drag. For example, six pieces, each 12 x 50 inches may be made in one mold. The length of the pieces is regulated by stop-off pieces. Proper spacing of stop-off pieces permits the production in one-half mold of three 20-inch pieces, or three 30-inch pieces and three 10-inch pieces from a pattern 50 inches long.

The foundry department of the plant of William Sellers & Co. Inc. comprises two core shops, a chipping shop, a cupola department and four molding shops.

One of the two core shops is arranged for heavy and the other for light cores. The heavy work core shop is equipped with a 20-inch cylinder, shockless, jar-ramming machine for ramming gravel cores, a centrifugal sand mixer and two large coke-fired core ovens with capacity for two cars each. The small work core shop is equipped with a core machine and with a multiple core oven for rapid drying of small cores. The large shop is served by a 10-ton overhead traveling crane equipped with two trolleys.

In the main casting shop, which also includes a large cleaning pit, the production involves large castings, such as lathe, planer and boring mill castings. These are molded in dry sand in the floor. Molding machines in this department include a 26-inch cylinder, shockless, jar-ramming machine with a 90 x 144-inch table and a straight jar-ramming machine with 13-inch cylinder and 6 x 6-foot table. In this department the molds are dried by charcoal briquettes held by salamanders which are hung in the mold. Copes are placed on cars and dried in a coke-fired oven, 18 x 35 feet and 15 feet high, located at one side of the foundry.

Two methods are employed in the main casting shop for sealing molds. In some cases the copes are tied down by binders. In others, they are weighted down by cast-iron weights. These are cast in various sizes up to 17 inches square in cross section and up to 20 feet long, and are provided with slots for the hook of the crane. A mold for a 48-inch planer bed 31 feet 6 inches long, is shown in Fig. 2. The cope is held down by weights aggregating 70 tons. The main transportation units in this department are cranes of an improved type. They have capacity for 40 tons each, and each has two 20-ton hoists, together with two 5-ton auxiliaries. The latter are intended for quick service on light work, thus lengthening the life of the heavy machinery of the cranes. Eight 5-ton hydraulic side-wall cranes also are used.

Have Large Capacity

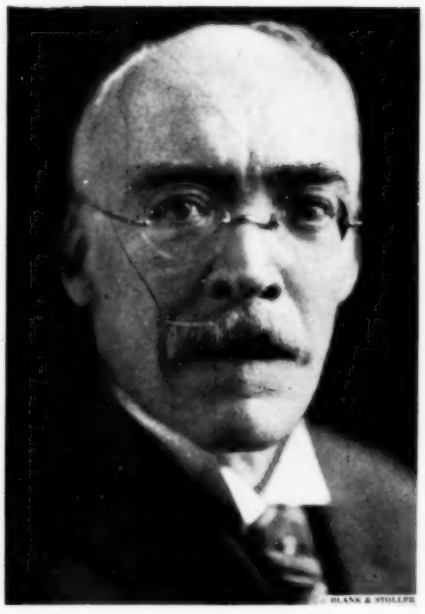
Three cupolas comprise the melting equipment. One has an inside diameter of 54 inches at tuyeres and the other two, 48 inches. The total capacity of the three is 27 tons per hour. Blast is provided by two blowers and the system is so arranged that either of the blowers can furnish the blast for any one of three melting units. The cupolas are bricked in alongside the foundry building and their spouts project into the main foundry through openings in the side wall of the building. Floor openings in which the ladles are placed for receiving hot iron from the spouts are covered with square iron plates when the cupola is not being tapped. These pits are lined with brick and the edges are reinforced with heavy iron copings in which the covers are placed. The capacity of the ladles used range from 2000 to 35,000 pounds each, so that large castings may be poured.

In addition to the main foundry, there are three smaller molding departments. One of these is devoted to the production of pulleys and small castings for machine tools and for locomotive injectors. It is equipped with three hydraulic and one hand-ram pulley machines, the latter being adaptable for pulleys as large as 72 inches in diameter. This department also is equipped with two 12½ x 19-inch squeezers and a small rollover.

A third foundry molding floor is devoted to small production work that may be made on machines and which fits into 26½ x 27½-inch flasks. This department is equipped with three molding machines of the squeezer type.

(*Concluded on Page* 859)

The FOUNDRY Family Photograph Album



Upper Left

J. H. WHITING

Whiting Corp., Harvey, Ill.

Lower Left

G. R. STENECK

Illinois Malleable Iron Co. Chicago

Upper Right

ARNOLD LENZ

Chevrolet Motor Co., Saginaw, Mich.

Lower Right

J. H. BRUCE

Bowler Foundry Co., Cleveland

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

A LEXICON OF TECHNICAL TERMS

(*Continued from Data Sheet No.* 736)

the eutectic would mean that three and four components respectively would separate out at a constant temperature.

Eutectic structure is an important microconstituent of many alloy series. It is usually some sort of laminar structure, each eutectic having its own characteristic form. The following eutectics are observed in the iron-carbon series: Ledeburite (4.3 per cent carbon—iron-carbon eutectic) and steadite (Fe_3C, Fe_3P—iron-phosphide eutectic).

The iron-carbon series are sometimes classified as follows: Eutectic cast iron—4.3 per cent carbon; hyper-eutectic cast iron—carbon content over 4.3 per cent, and hypo-eutectic cast iron—carbon content

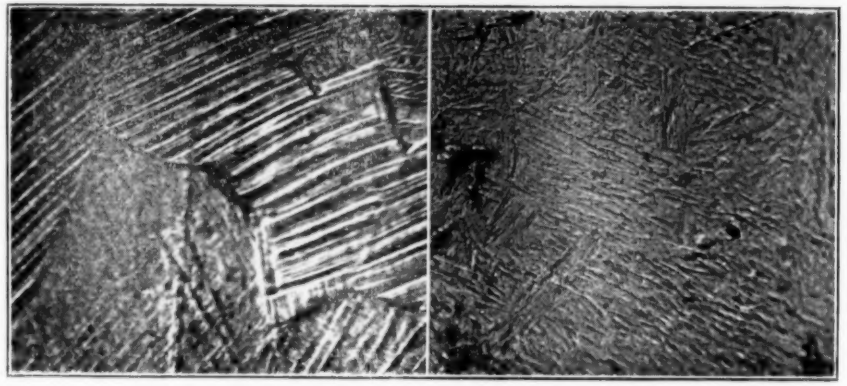


FIG. 9—AUSTENITE—MANGANESE STEEL—ETCHED, X 1000. FIG. 10—MARTENSITE STEEL—ETCHED, X 1000

less than 4.3 per cent. Fig. 7 shows the eutectic structure of white cast iron.

Eutectoid Structure

Eutectoid structure is the structural appearance of the eutectoid of any series as seen through the microscope. In a binary system the eutectoid is that composition which separates from a solid solution into its two components at a definite temperature (not a range). Austenite (gamma solid solution) separates into ferrite and iron carbide at about 710 degrees Cent. The eutectoid of the iron carbon series is called pearlite. Steels often are classified as follows:

Eutectoid steel with carbon content from 0.85 to 0.90 per cent; hyper-eutectoid steel with carbon content greater than 0.85 to 0.90 per cent, and hypo-eutectoid steel with carbon content less than 0.85 to 0.90 per cent.

(*Continued on Data Sheet No.* 738)

A LEXICON OF TECHNICAL TERMS

(*Continued from Data Sheet No.* 737)

The eutectoid, pearlite, of the iron carbon series is one of the most common microconstituents of the iron-carbon series and is shown in Fig. 8.

Austenite

Austenite is the solid solution microconstituent (gamma solid solution) of the iron carbon series. It is stable in ordinary carbon steels at temperatures between 700 degrees Cent. and its melting point depending on the carbon content. It seldom is observed in large amounts at ordinary temperatures in plain carbon steels. The alloying elements, manganese, silicon, nickel, cobalt, chromium, etc., change the location of the critical range, some raising it and some lowering it. For example: 25 per cent

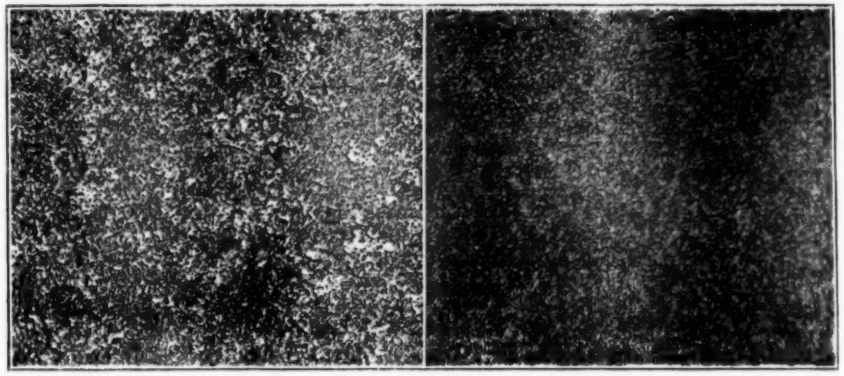


FIG. 11—TROOSTITE STEEL—ETCHED, X 500. FIG. 12—SORBITE STEEL—ETCHED, X 1000

nickel and 12 per cent manganese reduce the critical range so that austenite is quite stable at ordinary temperatures.

An austenite structure corresponds to a moderately hard and tough material in general, as is evidenced when austenite is tested at ordinary working temperatures, as in high manganese steel. The austenite structure of manganese steel is shown in Fig. 9.

Troostite

Troostite is a transition form in the breaking down of austenite into its constituents, ferrite, carbon (graphite) and iron carbide (Fe_3C—cementite). It is stated by some to be a direct transition from austenite without passing through the martensitic state. This theory is not accepted generally. Under the microscope it appears in rather indistinct masses resembling peanuts, or links of sausage, or may be a fine grained mass, as shown in Fig. 11.

(*Continued on Data Sheet No.* 739)

How and Why in Brass Founding

By Charles Vickers

Advises Use of Silicon

We have been told that magnesium is being added to aluminum alloys to improve the whiteness of the castings and to increase the fluidity of the metal. Can you tell us where to obtain magnesium and if it is added to the aluminum in stick form, or in the powdered form? Also how, and in what quantity is it used? What are its particular advantages? We use a No. 12 alloy, no scrap whatever except our own returned metal.

We have never heard of magnesium being used for the purpose mentioned, because it does not alter the color of the aluminum alloy to any noticeable extent, and neither will it increase the fluidity of the molten metal, or deoxidize it, or do anything else that would justify its addition to a regular No. 12 alloy. There are aluminum alloys that contain magnesium. In the case of duraluminum about 0.5 per cent of magnesium is added, and some alloys contain 1.5 per cent magnesium, which is added for a definite purpose, but is not connected with the color of the alloy, or its fluidity.

Additions of magnesium increase the casting difficulties associated with the founding of aluminum alloys in proportion to its content. For foundry purposes the massive form of magnesium only is used as the powdered variety would burn away before it could be mixed in the alloy. The casting properties of the No. 12 alloy can be improved considerably by incorporating about 2 per cent of silicon, and the best manner of adding it is in the form of a rich alloy of silicon and aluminum which can be purchased ready to use.

Lining an Iron Pot

We have asked several people for their opinions on using a clay-lined iron pot for pouring nonferrous metals, and they have advised against such use, claiming that the lining is not firm enough to prevent particles getting mixed with the metal, thereby causing dirty castings.

We assume that the clay-lined pot referred to is a ladle for carrying off and pouring brass and bronze, in which connection we can see no objections to such use, in fact in these days of noncrucible furnaces such ladles are widely used. There exists a divergence of opinion on this subject. Some founders prefer ladles, others prefer crucibles. Both ladles and crucibles have to be preheated before being used to contain liquid brass. Otherwise the metal would be chilled too much to give good castings. It may be possible that particles of the lining could break away and enter the mold with the metal, but this would indicate extreme carelessness on the part of those pouring off the molds.

Should any doubts arise about the clay lining, or any other daubed lining failing to give satisfaction, thin linings of firebrick are available, and can be obtained from the regular foundry supply houses. These are shaped to fit standard sizes of ladles and eliminate the possibility of the lining washing away.

Castings Are Thin

Kindly give the best formula for making brass thresholds that have to be polished, and also the proper way to do the work.

The following alloy ought to be satisfactory as it will polish and also cast easily: Copper, 85 per cent; tin, 5 per cent; zinc, 4 per cent, and lead, 6 per cent. A threshold is usually a long, thin and comparatively narrow casting. As a wood pattern will be supplied, the first difficulty that assails the molder is to ram up his drag without *springing* his pattern. As it is absolutely essential that this difficulty be surmounted to get a casting worth looking at, considerable thought will have to be given this matter at the start. It likely will be found a good move to put some wooden bars across the drag and to secure the pattern thereto with wood screws while the cope is being rammed up. When there is a large order of such castings, a metal pattern will save its cost easily. The usual manner of gating is to have a long runner alongside the pattern and connect with branch gates. Sometimes two runners are necessary; one on either side, but it is not possible to give any lucid idea of how they should be located in the absence of drawings. It will be advisable though to spray the mold with molasses water. Then flour it thoroughly, and apply the torch and skin dry the mold face.

Holes Occur in Faucets

We are making faucets and other plumbing articles which are tested to 125 pounds water pressure. We are using the best red brass scrap obtainable and are building the same up by adding scrap copper wire and 5 per cent lead. We are sending you a sample faucet which you will note shows considerable porosity on one side of the casting. Not all of the castings have this defect but it is seldom we are entirely free of it. What is the cause of this defect?

It looks as though the holes were caused by steam produced from dewdrops condensed on the core, and that the moisture was derived from the molding sand by using hot sand for filling in the flasks after the first heats had been poured. To illustrate this matter more fully we will suppose that the molder starts in with cold sand and puts up a heat, then is poured and his molds shaken out. In due time the hot sand is either *cut over*, a bad practice anyhow in a brass foundry, or it is riddled and so more or less mixed, but not tempered. It is steaming with heat. In making a mold the patterns are faced with cold sand, held in reserve for the purpose. Cold sand has to be used, otherwise the patterns would stick to the sand. The facing is backed with the riddled hot sand, and the work goes on, the molds being cored and closed and set for pouring. They have to wait for the metal, and during this wait, the steam in the backing sand permeates the mold cavities as vapor, and if the cores are colder than the steam, it is condensed on the cores.

When the flowing metal touches this dew, steam is produced always and some of it gets folded in with the metal making the holes. The remedy is to be more liberal with the molding sand; give the molders more space and more sand so that the hot sand will be given time to cool considerably below the steaming point. Porosity of your castings is not caused by the way the metal has been melted. It is good, sound metal properly melted. The cores are also blameless, the difficulty arises in the molding. The sand may be too close, but in such case the porosity would not be localized as in the sample sent for inspection.

Melting Iron in the Cupola

By J.E.Hurst

Part IV

EVEN in drop bottom cupolas in Great Britain the custom still obtains of providing a large opening in the cupola shell through which the hearth and bottom may be prepared upon the closed bottom doors. This opening referred to as the fettling door generally is located diametrically opposite the tapping spout, and also is arranged to support the slagging spout when the door is closed. No special reason beyond that of mere general convenience is responsible for a fettling door and slagging spout embodied in one and located diametrically opposite the tapping spout. They might just as well occupy some other position relative to the tapping spout providing always that the slagging spout is located between two tuyeres or the tuyere doors and never immediately below a single tuyere.

Slag and tapping spouts in the Whiting and Colliau types of cupolas are provided in the main shell at the required levels. The method of holding the tapping spout in position is shown in Fig. 19. The method adopted in these types of forming the tap hole can be arranged in other cupolas and is advantageous, particularly in those cupolas where the lining is specially thick. The author favors the arrangement shown in Fig. 20. The lining is exceptionally thick and this arrangement allows the formation of a shorter tap hole. In this form of construction the breast and tap hole may be taken out and completely reconstructed in the middle of the heat. The manner in which this is done is described in another article to appear later.

A simple form of slag hole arrangement consisting of an oval opening arranged at a suitable level in the cupola shell was shown in Fig. 12. A suitable spout is bolted to the shell to conduct the slag away. The tap hole in this cupola is formed in a similar manner and a simple elongated hole is provided in the shell diametrically opposite the fettling door. The tapping and slag spouts generally are made of mild steel plate and are lined with suitable refractory material. Occasionally cast iron spouts are specified.

Two arrangements of fettling doors and clamping arrangements were shown in Figs. 12 and 14 respectively. In the Pneulec arrangement Figs. 12 and 32, the fettling door is held in position by a yoke bar and wedges. The alternative method using T-headed screws in the yoke bar, was

Uses Fettling Door

THE fettling door at the back of the cupola is one of the distinctive features which serve to differentiate between British cupolas and those built and operated in America. Many American foundrymen, who in this chapter are introduced for the first time to this device will wonder at its continued use. Interesting features in tapping and slagging spouts also are presented. Fairly extended reference is made to wind belt and air mains, tuyere and tuyere control, spark arresters and dwarf cupolas.

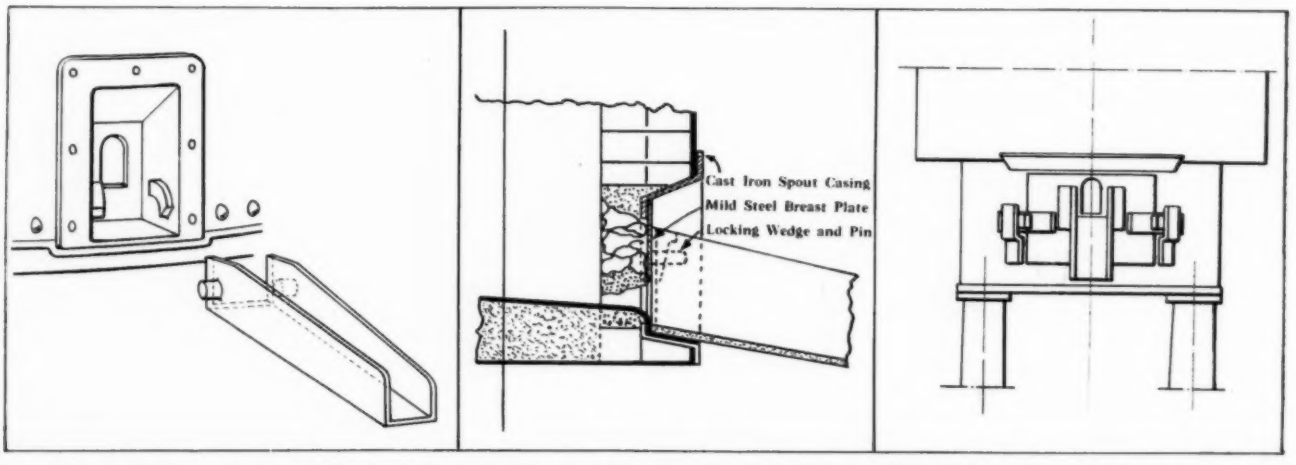
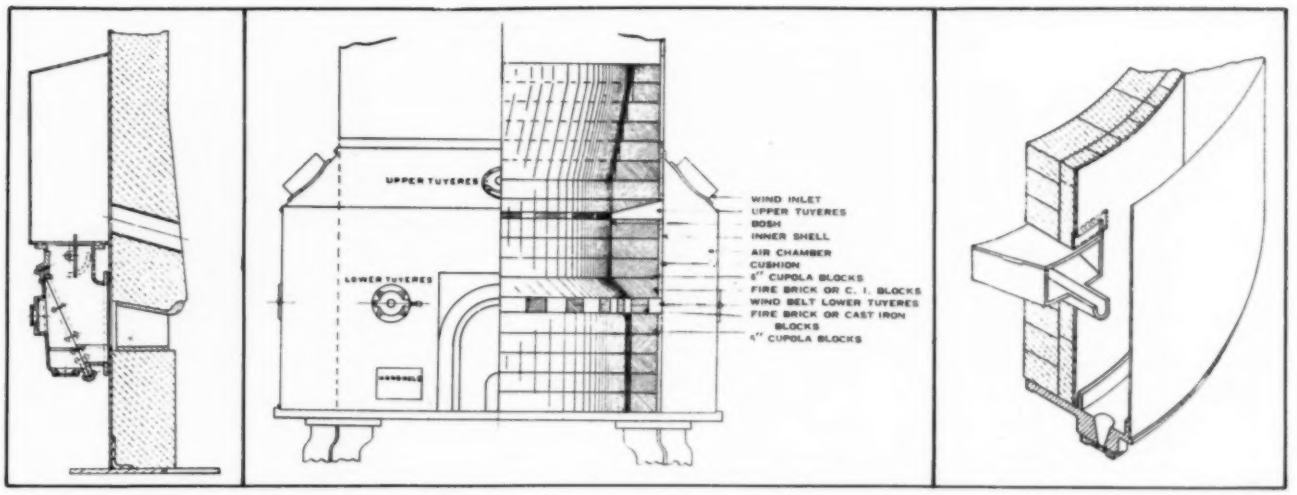


FIG. 19, 20 AND 21—ILLUSTRATING DIFFERENT METHODS EMPLOYED IN PREPARING THE TAP AND SLAG HOLES AND SPOUTS



FIGS. 22, 23 AND 24—INDIVIDUAL SHUTTERS ARE PROVIDED ON THE TUYERES FOR CONTROLLING THE BLAST ON SEVERAL DIFFERENT TYPES OF MODERN CUPOLAS

shown in Fig. 16 which appeared previously.

The method used by the author for combining slagging spout and fettling door is shown in Fig. 21. This is a convenient method of arranging the slagging spout in smaller cupolas. Standard cupola arrangement provides for one tapping spout only, but more than one spout may be provided if necessary. These should be arranged at slightly different levels.

Simplest and most common form of wind belt construction, particularly in the smaller cupolas consists of an annular box of rectanular section arranged around the cupola shell as shown in Fig. 12. The wind belt formed of flanged steel annular plates is riveted to angle iron rings attached to the cupola shell. Air enters through a double flanged inlet tube containing a simple butterfly valve, and attached to the casing of the wind belt, also provided with suitable tuyere doors, inspection and cleaning doors. In the wind belt illustrated in Fig. 11, holes are provided immediately underneath the tuyeres. They are closed by strips of sheet lead held in position by an annular cast iron flange bolted to the underside of the wind belt. The object is to prevent accumulation of molten slag in the wind belt due to accidental rising of metal and slag above the tuyere level.

Have Two Air Pipes

A similar form of wind belt, illustrated in Fig. 12, is divided vertically at a point diametrically opposite the air inlet. A baffle plate at the air inlet and clearly shown in the illustration, divides the air supply into both sections of the belt.

In the older cupolas possessing two rows of tuyeres, the wind belt usually was divided about the horizontal plane into two sections containing the upper and lower tuyeres respectively. Air from the main air supply was supplied to each section separately, by a breeches pipe. A separate main air control valve was provided for each section for the air belt.

A special form of wind belt construction fairly common on some of the larger types of standard cupolas is illustrated in Fig. 32. The wind belt is formed of a pipe from which the tuyeres are dropped by a modified form of blast furnace goose neck. Inspection covers are provided on each separate tuyere. It is claimed that a much smoother flow of air is obtained from this construction. A resemblance may be noted between this and the Whiting special cupola construction illustrated in Fig. 11.

Wind belt and tuyere control on the standard series of French cupolas

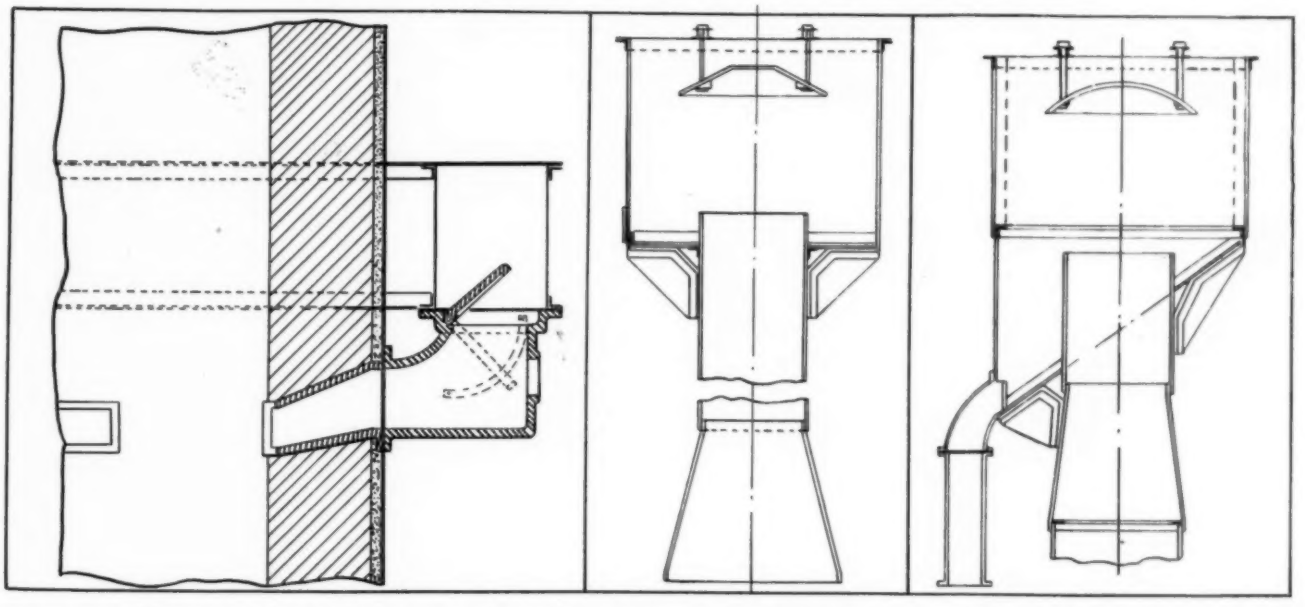


FIG. 25—ONE METHOD OF CONTROLLING THE AIR PASSING THROUGH THE TUYERES. FIG. 26—(CENTER) ONE TYPE OF SPARK ARRESTER USED ON A BRITISH CUPOLA. FIG. 27—A SPARK ARRESTER OF THE SELF CLEANING TYPE

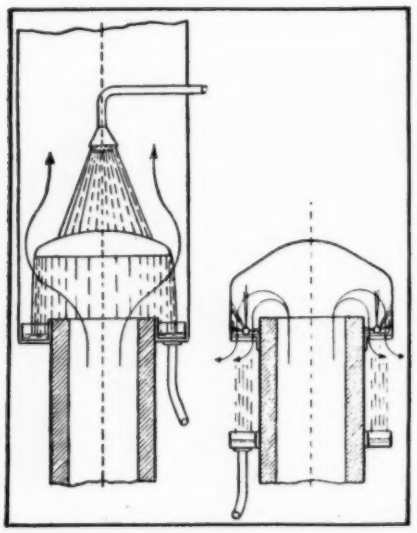


FIG. 28—A WATER SPRAY TYPE SPARK ARRESTER

previously referred to is illustrated in Fig. 25. The simple and effective nature of this tuyere control is clearly evident from the illustration.

The Whiting standard wind belt construction illustrated in Fig. 24 is built up from the specially flanged foundation plate to a conical slope on the top surface. This conical surface prevents the lodgment of dirt and water at this point and consequent corrosion on cupolas in exposed positions. This feature also is adopted in the Colliau and Titan types. In the latter the wind belt is welded to the cupola shell.

In the American cupola shown in Fig. 13, the wind belt is constructed independently of the base plate. The bottom is made up of cast iron plates with a flanged steel top and sheet steel sides. All the joints are made tight with sheet asbestos. The wind belt is provided with the necessary cleaning doors and tuyere inspection covers. The wind belt in cupolas up to 60 inches in diameter need not exceed ¼-inch thickness of plate. Above 60 inches diameter 5/16-inch plate is used. Closer riveting at 2½-inch pitch is necessary in riveted constructions to render the wind belt air tight.

Air inlet generally adopted is a single inlet of large enough diameter to pass the requisite quantity of air. An air main control valve of the simple butterfly type is provided. In the Whiting cupola, the air inlet is attached tangentially to the wind belt. In the Paxson-Colliau cupola the air enters through two openings which are placed in the upper surface of the wind box.

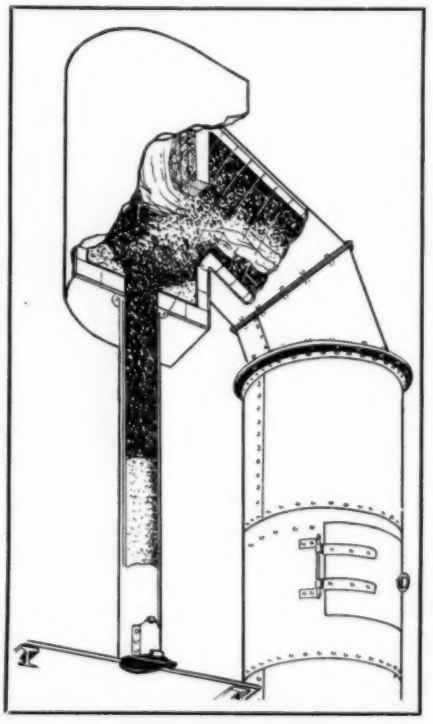


FIG. 30—A SPARK ARRESTER WHICH CARRIES THE DUST AWAY

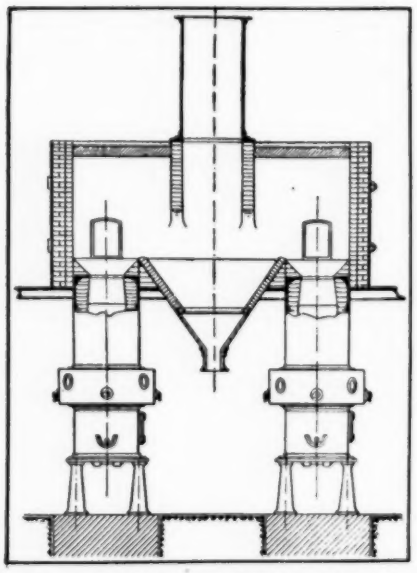


FIG. 29—EXPANSION CHAMBER SPARK ARRESTER

Standard cupolas vary extensively in shape and number of tuyeres. Most makers adopt two rows of tuyeres as standard. The Stewart cupola for a time extensively quoted in textbooks carried three rows of tuyeres, but this arrangement now appears to be abandoned. Several makers are adopting a single row of tuyeres only as standard. Dimensions of these are large enough to allow sufficient volume of air to be admitted to the cupola.

The Whiting cupola has standardized two rows of tuyeres. The bottom row, rectangular in shape, expands through a small area to a large opening inside the cupola. Internal area of these tuyeres is approximately double that of the area on the external surface, and the internal openings form an almost continuous belt around the cupola. The upper row of tuyeres similar in construction to the lower, are intended to supply sufficient air to utilize to the fullest extent any escaping fuel gases. A simple form of individual damper for regulating purposes is provided.

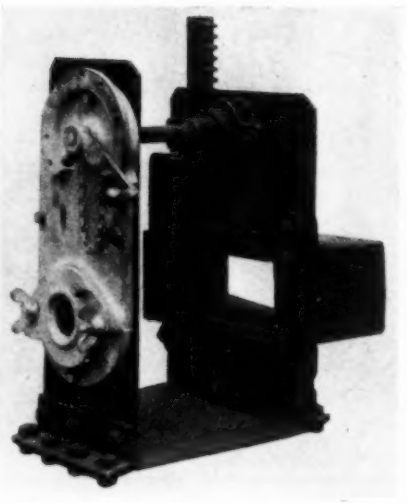


FIG. 31—RACK AND PINION TYPE TUYERE SHUTTER

Two of the bottom row of six tuyeres in the Whiting cupola are equipped with spouts through which the slag or iron will flow before it reaches any of the other tuyeres. The spout leads the overflow to a hole in the bottom plate of the wind belt. This hole usually is covered with a sheet of lead through which the hot slag or iron readily penetrates.

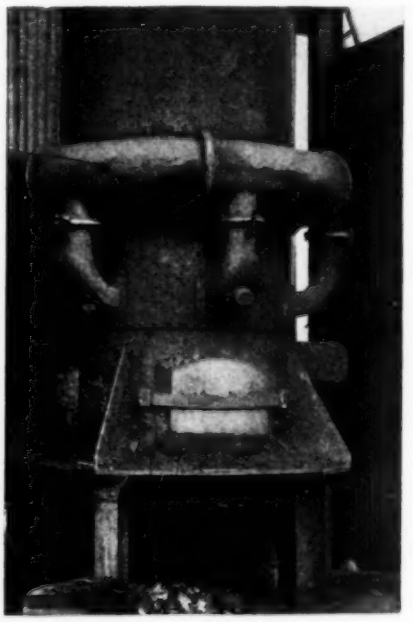


FIG. 32—SPECIAL CAST IRON WIND BELT AND TUYERES

Hinged covers fitted with mica covered peepholes are provided in the wind belt casing, immediately opposite each tuyere to permit of examination and cleaning.

In the adjustable tuyere system on the special Whiting cupola illustrated in Fig. 22, the lower tuyeres consist of three parts: (1) Tuyere cover, a continuous set of segments that interlock with each other. (2) Tuyere cover supported by the triangular vertical section of the base plate. (3) Adjustable side plates. The circular upper tuyeres of this special cupola slope downward.

Use Special Tuyeres

Paxson-Colliau tuyeres are similar to the Whiting in the bottom row. The top row of circular tuyeres tapers to the inner surface as illustrated in Fig. 13. Tuyere covers for the top row are arranged on the sloping top of the wind belt. A special system of tuyeres in conjunction with a boshed construction of the tuyere zone in the Paxson cupola and illustrated in Fig. 23 is designed for the introduction of a large volume of air into the melting zone at low pressure and velocity.

A venturi shaped arrangement is adopted in the Thwaite Rapid type of cupola in both rows of tuyeres. A single row of tuyeres of rectangular section flared to the inner diameter of the cupola is the standard construction on the Titan cupolas.

Generally speaking, the tuyeres are supplied as iron castings, bolted on the interior of the cupola shell. Individual damper control is fitted to most modern cupolas. Arrangement of the Davis damper, a sliding shutter operated by a rod drilled at intervals for varying degrees of opening was illustrated in Fig. 14. A substantial form of sliding shutter operated by a rack and pinion is illustrated in Fig. 31. A tuyere damper of the guillotine type is adopted on the Titan cupola. An ingenious double sight hole which permits poking and observation of the tuyeres to be carried out simultaneously is supplied on cupolas made by the Constructional Engineering Co., Birmingham.

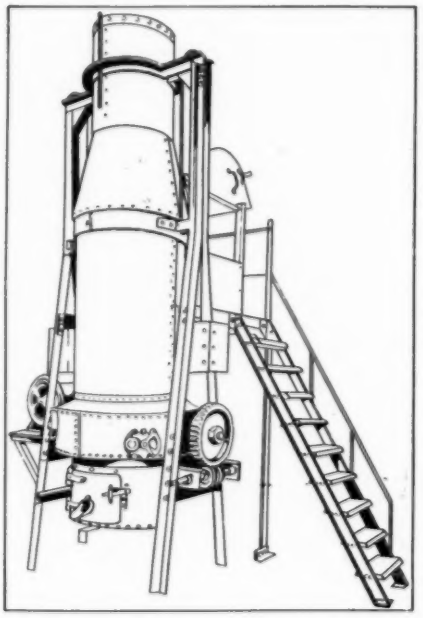


FIG. 33—A SMALL TILTING TYPE CUPOLA

Table IV

Typical Leading Dimensions of Cupolets

Capacity per hr., hundredweight	Total height from floor, feet	Outside diameter, inches	Inside diameter, inches	Total weight, tons
5 to 10	6.0	24	18	11
10 to 15	9.25	24	18	15
15 to 20	9.5	27	20	17
30 to 40	9.25	36	23	22.5

Apart from danger arising from sparks carried away from cupolas in populated areas, saving in cost in the maintenance of roof lights and roof drainage in modern foundry buildings by the installation of spark arrestors is becoming increasingly realized.

Various spark arrestors have been adopted, all of which are of the simplest type. Economy of the cupola plant does not permit installation of the elaborate dust extracting appliances found in blast furnace plants. The spark arrestors generally employed present an adaptation of some form of expansion chamber on top of the cupola, generally in combination with a baffle plate arrangement. Expansion reduces velocity of gases carrying the sparks and allows the earthy matter and sparks to be deposited where provision is made for accumulation and withdrawal of the material. Analysis of the sparks collected from a cupola plant in this manner follows:

Carbon 47.44 per cent (Chiefly coke dust)
Silica 37.75 per cent (chiefly sand)
Iron oxide 12.25 per cent
Lime 2.00 per cent
Magnesia 0.56 per cent

A simple type of expansion chamber diagrammatically illustrated in Fig. 29 is arranged for two cupolas. Gases from the cupolas are discharged into a large and substantially built brick chamber. Reduction in the velocity of these gases allows the deposition of sparks and dust and this is assisted further by the baffle walls built around the chimney-like exit provided to the chamber. A conical chamber provided for collection of dust leads to a pipe extension provided for the removal. The angle of this chamber should not be less than 55 degrees to allow free flow of collected material. The chimney exit preferably should be covered in a manner to prevent the entry of rain which is rapidly absorbed by the dust and prevents its easy removal. A chamber of this nature usually is constructed of firebrick and reinforced by suitably disposed tie rods. Weight of the whole structure necessitates substantial superstructure. This probably is the most effective spark arrestor but its first cost is high.

Simplest form of spark arrestor is an inverted, dished baffle plate attached to the top of the cupola and arranged to deflect the sparks into an annular cavity arranged round the top of the cupola as illustrated in Fig. 26. This type is employed extensively on small cupolas used intermittently for short periods. An elaboration on this form, illustrated in Fig. 27, provides means for the withdrawal of the collected material.

The Osborn type spark arrestor illustrated as applied to a single cupola in Fig. 30 has been extensively adopted in Great Britain. It is really a compact form of an expansion chamber and baffle plate construction with means for removal of the deposited material. These latter types are comparatively inexpensive, since they do not need the heavy superstructure necessary for the brick chamber referred to previously.

In totally different types of spark arrestors illustrated in Fig. 28 the sparks are arrested and quenched by a spray of water. Their action is clearly depicted in the diagrams. The author has no experience of their practical use, but it is evident that ample exit waterways will be required to prevent stoppage from accumulation of sludge material.

Cupolets or Dwarf Cupolas

What might be regarded as miniature cupolas are standardized by cupola builders for special experimental uses, and for use in temporary situations. These cupolas generally are referred to as cupolets or dwarf cupolas. Their melting capacity varies from 1000 to 3000 pounds per hour, and they are extremely simple

in design consisting of a mild steel shell supported on cast iron trunnions and *A* frames. Two tuyeres are arranged to pass through the hollow trunnion spindles, and are provided with a simple shutter type blast gate and peephole doors with mica inspection windows. For convenience in cleaning and relining the smaller diameter units, the whole shell can be tilted to a horizontal position on the trunnions. A hinged steel leg is provided to support the shell in this position. The cupola is equipped with a solid cast iron hinged drop bottom door well drilled for venting purposes. The ganister or silicious fireclay lining is rammed around a wood pattern of the requisite diameter. Typical standard dimensions of a series of baby cupolas is given in Table IV and an illustration of a complete unit with fan and blast pipes is shown in Fig. 33. These cupolas are used in small foundries, for experimental purposes, and they can be mounted on carriages or rollers to form portable units.

Acquires New Property

The Milwaukee Foundry Equipment Co., 284 Seventh avenue, Milwaukee, recently has acquired 92,000 square feet of property located at 1204-1212 South Pierce street, Milwaukee, where it will erect a modern building for the manufacture of molding machines.

Suggest Code for Buying and Selling

Believing that lack of appreciation of the common interests of buyers and sellers is responsible for unnecessary losses to American industry, a committee working in co-operation with the National Association of Purchasing Agents has launched a campaign of education to reduce this waste. As a basis for action the committee, which met Sept. 28, at the Commodore hotel, New York, unanimously adopted proposed standards for buying and selling, which are reproduced on this page. It is hoped that by pointing out the tremendous burden placed upon industry by ill-advised tactics of certain salesmen and purchasing agents, sentiment will be created which gradually will result in the adoption of more efficient practice in these departments.

The campaign is the outgrowth of a conference called by the National Association of Purchasing Agents in May to consider the responsibility of purchasing agents in the "profitless prosperity" era.

The consensus of opinion developed at this meeting was that "profitless prosperity" is a natural phase of a buyers' market, that "beating-down price" tactics and unscrupulous methods indulged in by some purchasing agents are not typical, that lack of price courage is a major contributing factor to "profitless prosperity," and finally that the most effective cure for existing conditions lies in the development of better understanding between sales and purchasing department officials.

In resuming the thread of discussion at the Sept. 28 conference, attention was directed to the fact that confidence should be the basis of successful selling. It was said that business deals conducted on the theory that "If I do not get him, he will get me," can only breed dissatisfaction. It was agreed that a vindictive attitude in buying or selling has no place in modern business.

Forms Partnership

Horace J. Young, consulting metallurgist and chemist, 3 Central buildings, Westminster, London, S. W. 1, has taken George Shaw, Durham, Eng., into partnership and will practise under the name Young & Shaw, analytical and consulting chemists. Mr. Shaw will have charge of the Newcastle laboratories of the company located at 497a Shields road, Walker Gate, Newcastle-on-Tyne. This laboratory is equipped to carry on chemical testing and mechanical inspection. Mr. Shaw for the past three years has been in partnership with Mr. Stock, public analyst for Durham county.

Proposed Standards for Buying and Selling

(PROPOSED BY THE NATIONAL ASSOCIATION OF PURCHASING AGENTS)

UNNECESSARY sales and purchasing expense is an economic waste—a tax on legitimate industry. Its elimination will assure satisfactory profits to the producer, economy to the consumer, and greater efficiency in commercial relations.

We recognize that the concern which buys must also sell, that buying and selling are companionate functions that sound commercial transactions must be mutually profitable, and that co-operation between buyer and seller will reduce the cost of purchasing, sales and distribution with consequent benefits to industry as a whole.

In furtherance of these principles, we subscribe to the following standards in our buying and selling:

1. *To buy and sell on the basis of value, recognizing that value represents that combination of quality, service and price which assures greatest ultimate economy to the user.*
2. *To respect our obligations and neither expressly nor impliedly to promise a performance which we cannot reasonably expect to fulfill.*
3. *To avoid misrepresentation and sharp practice in our purchases and sales, recognizing that permanent business relations can be maintained only on a structure of honesty and fair dealing.*
4. *To be courteous and considerate to those with whom we deal, to be prompt and businesslike in our appointments, and to carry on negotiations with all reasonable expedition so as to avoid trespassing on the rights of others to the time of buyers and salesmen.*
5. *To avoid statements tending to injure or discredit a legitimate competitor, and to divulge no information acquired in confidence with the intent of giving or receiving an unfair advantage in a competitive business transaction.*
6. *To strive for simplification and standardization within the bounds of utility and industrial economy, and to further the development of products and methods which will improve industrial efficiency.*
7. *To recognize that character is the greatest asset in commerce, and to give it major consideration in the selection of customers and sources of supply.*
8. *To adjust claims and settle disputes on the basis of facts and fairness, to submit the facts to arbitration if a mutual agreement cannot be reached, to abide by the decision of the arbiters, and to resort to legal measures in commercial disputes only when the preceding courses prove ineffective.*
9. *To provide or accept no gifts or entertainment in the guise of sales expense, where the intent or effect is to unduly prejudice the recipient in favor of the donor as against legitimate competitors.*
10. *To give or receive no bribes, in the form of money or otherwise, in any commercial transaction, and to expose commercial bribery wherever encountered for the purpose of maintaining the highest standard of ethics in American industry.*

WHAT OTHERS ARE THINKING

Abstracts Selected from the World's Foundry Literature

Employs Continuous Methods

Continuous Operations in the Foundry. Present-Day Conditions in Germany, by M. Brieger. *La Revue de Fonderie Moderne*, Paris, August 10, 1928.

Continuous methods have been imported from America and generally are known on the continent of Europe as the Taylor system. In Germany, a limited number of industrial branches are equipped for mass production. Extension of the system is retarded in some cases by lack of capital. In the foundry, mechanical means of production have reached a high degree of perfection by the use of modern molding machines, but there still is room for great improvement in methods of working.

To manufacture one ton of castings, between 100 and 200 tons of raw materials must be handled, and there is a distinct advantage in facilitating the handling of these materials. The rapid circulation of materials results in the rapid circulation of capital. The article divides handling methods into two groups; one includes raw materials moving to and as far as the cupola, and the other includes all products located inside the foundry shop such as liquid iron, sand, flasks, etc. The mechanical handling of the first group generally is practised. In the second group, continuous methods are justified in repetition work and if the cupola gives a continuous supply of liquid metal. An advantage of continuous methods that sometimes is overlooked is that it saves space. The speed of the conveyor is studied. It is pointed out that, in America, for certain rapid operations the operator himself is transported on a conveyor which accompanies the work during a given time. Whereas in America the tendency is to employ the simplest means possible for the transportation of materials, such as gravity, or chutes, in Germany roller conveyors are used to a greater extent.

Welding and Cutting Cast Iron

Welding and Oxy-Acetylene Cutting of Cast Iron, by M. Lebrun. *Bulletin*, Association Technique de Fonderie de Paris, August, 1928.

The welding industry in France employs 45,000 workers, consumes annually 60,000 tons of carbide of calcium and 20,000,000 cubic meters of oxygen. Two methods of welding of interest to the foundryman are oxy-acetylene welding and arc welding. The hottest part of the flame in a blow-pipe has a temperature exceeding 3000 degrees Cent. The hottest zone should not come in contact with the casting, as it would decarburize the iron. Cast iron welding wires should contain a minimum of 2 per cent silicon and only traces of manganese so that the welded part may be machined easily. Such welding wires are sold, containing 5 per cent silicon and are from 5/32 to 9/16-inch square. As the oxide formed during the welding process melts at a higher temperature than the iron, it is necessary to use a flux which is chosen so that it may have the effect of recarburizing the iron. The flux generally is a powder composed of a mixture of carbonate and bicarbonate of soda.

In arc welding the temperature of the flame is about 3000 degrees Cent. To prevent the formation of white cast iron, the electrodes are made of gray iron with high silicon content, and they are coated with graphite. Before the welding operation, the casting must be heated to a temperature ranging from 600 to 700 degrees.

Reference is made to the cutting of cast iron. A slab, 1¾ inches thick, can be cut at a speed of approximately 2 inches a minute. Methods of reinforcing a piece with studs before welding also is described. Various applications of welding and cutting are given, and the article also refers to the welding of cast steel, bronze, brass and aluminum alloys. In conclusion, the author states that there are many instances where the welding industry competes against casting, but it should be possible, by intelligent co-operation, to develop both industries jointly.

Discusses Cupola Blowers

Blowing Apparatus, by Albert Bouzy. *Bulletin* of the Association Technique de Fonderie de Paris, July, 1928.

The author deals particularly with cupola blowers and with the control of blowing. The article is limited to the study of centrifugal or fan blowers, and the theory of the apparatus is given, accompanied by formulas and charts. The control of the blast is effected with respect to the pressure at the intake and to the output volume. Recording instruments are preferred to ordinary indicator instruments, as the charts enable comparisons to be made and results to be discussed and improved. Such instruments are described and a theoretical discussion of a blast measuring apparatus is given.

Describes Loam Molding

Loam Molding, by J. E. P., *Foundry Trade Journal*, London, Aug. 9, 1928.

The author of this article presents a short description of the method used in making a mold for an axle for a large gas exhauster in loam. After the brick work is erected the walls are daubed with dungy loam. Then a facing of hairy loam is worked up with a strickle board. The author compares the use of this hairy loam to facing sand in green sand molding, stating that it gives a much better and smoother surface to the casting. After the mold is dried, it is blacked with a mixture of two parts of charcoal and one part of carbon blacking which had been mixed thoroughly and allowed to stand for a week.

Nickel Chromium Iron

Critical Points and the Martensitic Quench in Ni and Ni-Cr Cast Iron, *Foundry Trade Journal*, London, Aug. 16, 1928.

Tests were carried out by Guillet, Galibourg and Ballay on the martensitic quenching of cast irons containtaining nickel and nickel-chromium. The irons contained 3.2 to 3.4 per cent carbon, 0.90 per cent phosphorus and varying amounts of silicon, manganese, nickel and chromium. Two rates of cooling were used, namely, slow cooling in the furnace from 950 to 450 degrees Cent. at 8 to 10 degrees per minute; rapid cooling in the furnace by air blast from 950 to 450 degrees Cent. at the rate of 250 degrees per minute. Positions of the critical points and brinell hardness tests obtained are presented in a table, and the results led the authors to the following conclusions:

Silicon lifts the transformation temperature and increases the critical quenching speed. Consequently, it lowers the tendency of the quench to be martensitic. Moreover, it reduces the same tendency to primary quenching consequent upon the precipitation of carbon as graphite. Between 0.20 and 0.65 per cent manganese slightly lowers the temperature of transformation. It acts on the critical rate of cooling so that it distinctly lowers quenching. It apparently influences quite appreciably the hardness after secondary quenching. Within the same limits of contents, manganese has conversely only an insignificant action on primary quenching. Nickel lowers the temperature of transformation and the critical quenching cooling rate. It permits lowering of the change point to below 350 degrees Cent. Thus it operates favorably on the secondary quenching because by aiding the precipitation of graphite, it lessens the tendency to primary quenching. Chromium when added to a nickeliferous cast iron lowers the quenching critical rate of cooling, and has, as in steels, a strong influence on secondary quenching. Logically it increases the penetration of martensitic quenching. These tests clearly indicate the potentialities for the industrial utilization of nickeliferous and nickel-chrome cast iron which should be resistant to wear and of two kinds: Easily machinable irons as cast and yet susceptible to hardening by heating to about 800 degrees Cent. and cooling in still air or air blast according to the mass of the casting; cast irons resembling self-hardening steels —that is hard *as cast*—but being easily machinable after a short normalizing carried out at 650 degrees Cent. After machining, these irons which are susceptible to chill, can be hardened easily by heating to about 900 degrees Cent., and cooling in air.

Reproduces Sphinx in Aluminum Alloy

(*Concluded from Page* 831)

The pedestal shown in Fig. 6 was cast in several sections. One of the side panels castings is shown in Fig. 12. It is 18 inches wide, 10 feet in length, ½-inch thickness of metal, was gated all the way along on both sides and came out of the mold perfectly straight. Sections into which the main figure was divided include the center front, that is, the face, neck and breast; right and left draperies; right and left paws; right and left wings; right and left tail pieces; right and left head and crest; and two plates to form the plain back.

Front and back views of the center casting section are shown in Figs. 18 and 20. The plaster impression from which the drag part of the mold was formed is shown in Fig. 19. The casting is approximately 10 feet in length and was poured from four sets of runners located near the four corners of the flask as may be noted in Figs. 18 and 20. The flange for bolting this section to the others was formed in the cope part of the mold as may be seen by examining the parting line on the casting. Incidentally, these pictures were taken immediately after the casting was shaken out and the practically entire absence of fins indicates how nicely the cope and drag sections of the green sand mold coincided, even though they were rammed on separate patterns.

Use Wood Frames

Progress pictures illustrating construction of the various pattern sections are shown in several of the accompanying illustrations. Frames ready to remove from the front of the Sphinx are shown in Figs. 8 and 10. A frame in a similar condition on the left side of the head is shown in Figs. 3 and 7. The white line indicates the average plaster thickness. It also marks the parting line which follows a center line from the forehead of the figure, over the crest and down to a point where the neck merges into the back.

Method of constructing the patterns and mold for one of the wing castings is illustrated in Figs. 7, 13, 14, 15, 16 and 21. With minor modifications due to size, shape and relative position of the section, it was the method followed in making all the patterns for the Sphinx.

Fig. 21 shows the wood frame in position against the side of the plaster model. This frame was made from a number of 2 x 4 pieces of lumber, flat on the back and conforming in a general way to the shape of the pattern face on the front. A number of bars, corresponding to the bars in a flask were attached to the 2 x 4s and a number of narrow strips, shown more clearly in Fig. 7, were nailed to the face of the bars. These strips were designed to approach within about 1 inch of the pattern face.

With everything in readiness the frame was removed temporarily. The face of the plaster Sphinx over the required area was oiled to prevent adhesion of the new plaster. A thin coating of plaster was painted on the surface and then the frame again was adjusted in place. The sculptor threw soft plaster in handfuls through the wood frame onto the surface of the plaster model. Short pieces of burlap were attached to the light wood supports. The free ends were pressed into the soft plaster. In this manner the plaster face was anchored firmly.

Template Locates Holes

After the plaster had been built to a thickness of about 3 inches it was trimmed accurately around the four sides to coincide with the predetermined parting lines marked on the model. The frame then was removed and propped up on the floor in a horizontal position where a supplementary frame of flat boards was built around it to support it in a uniform position on the floor of the foundry and to form the joint and parting line for the two mold impressions. A templet was employed to locate the pin holes in two opposite ends and this same templet served to locate the pin holes in the joint of the flask and in patterns for other sections designed to be molded later in the same flask.

In Fig. 7 the wood patternmakers have finished their work and the sculptor is shown putting the finishing touches to the plaster impression. This impression corresponds to a negative in photography and if the metal was poured against it the result would be a duplicate of the original model. Unfortunately, this procedure is not practical. A sand mold must be prepared for the reception of the metal. Normally two further impressions would be required to accomplish this result, but a little ingenious manipulation reduced the moves to one.

After the sculptor had touched up the pattern face and smoothed the parting surface all around the edge, he rolled clay into strips ½-inch thick and laid these strips closely all over the face of the plaster face. This clay thickness corresponded to the proposed thickness of the casting. The second frame which is shown standing in Fig. 7 was adjusted as a cope on the lower part and plaster was applied as in the first instance. After the plaster had stiffened, the two plaster frames were separated and prepared for delivery to the foundry. Here were an inside and outside impression of the model in plaster. Manifestly if an impression were taken from these two parts in sand, the sand parts would fit as readily as the two plaster parts. The only difference was that the drag plaster mold yielded the cope sand mold and the cope plaster mold served as a base on which to ram the drag sand mold. After the drag plaster mold had served its purpose in the pattern shop, the thickness strips were removed and the two plaster molds, which now were destined to serve as patterns were taken into the foundry.

A slight complication was introduced in this particular casting, also in the corresponding casting on the opposite side, by the presence of one fold of the drapery. This feature was taken care of by blocking a space around the pattern and by forming a plaster corebox in sections. Dry sand cores were made in this corebox, or set of coreboxes and placed in the block print in the drag mold as shown in Fig. 13. The overhang of the cores was supported on light stud chaplets.

Iron Bars in Cope

In making the mold the drag half of the flask was placed on the plaster pattern and frame shown in Fig. 16. The drag was filled with sand, rammed and rolled over in the usual manner. The plaster filled frame then was removed and the drag part of the mold was prepared by spraying the surface with molasses water, cutting the gates and setting the cores.

The cope which in the meantime had been rammed by a second gang on the pattern shown in Fig. 15 was lifted directly from the pattern and mounted on four horses or trestles where minor imperfections on the surface were repaired. The wood cope was barred in the usual manner and was provided with two cast iron bars located equidistant between the center of the flask and the ends. The handles for lifting the cope were bolted to the ends of these bars. A continuous gate was cut in the joint along two ends and the metal was poured through four runners at the corners of the flask. A *storge* or cleaner effect was secured by placing a riser on the main runner at each point where a branch gate entered the mold. These also acted as risers.

Bill Comments on the Lost Wax Process

By Pat Dwyer

WHEN Bill came in the other night he found me comfortably propped in a semireclining position on two chairs and engaged languidly in looking through the evening paper. With any other person appearing on the scene I would have thrown the paper away, assumed a more dignified and consequently a more uncomfortable position. In accordance with the solemn rites of hospitality as laid down in the book of etiquet (only one *t* my dear) I would have welcomed him effusively, begged him to hand me his hat and coat and then racked my tired brain to engage him in sprightly conversation.

Fortunately Bill's status as an old friend, trusty and true, if at times a trifle tiring, absolved me from this fatiguing obligation. He is as free in my house as he is in his own and is fully competent, and welcome, to hang up his own hat and coat. In one respect he is the most welcome of all visitors. He is quite ready and willing to do all the talking. All I have to do is listen and maybe say "yes" now and again. 'Tis an ideal combination. He derives a certain amount of pleasure from hearing himself talk, while I, in my capacity of host and entertainer am required to exert a minimum amount of physical and mental effort. You would travel many a long sea mile, Tom Darcy, before improving on that set of conditions!

Just before he arrived I had read a short item of news from the other side dealing with a hunting excursion some place in Germany in which Hindenburg the famous old war lord had taken part and had shot two deer. The item was headed, "Hindenburg Shoots Two Bucks." Therefore, when Bill in his usual manner inquired carelessly and apropos of nothing at all: "Well, what's the noos?" I replied that the most startling story I had seen so far was a short item claiming that Hindenburg shoots two bucks. "Shoots two bucks, hey?" said Bill, "he's only a piker. You'd think a bird like him, president of the country and all that kind of thing with all kinds of Jack would shoot at least ten bones for a starter. The old lad may have been a wow in the art of war, but I'll tell the pop-eyed world he is a long way behind the procession in the arts of peace. Shoots two bucks! I wonder where he learned the game? Certainly not from members of the A. E. F., who cheerfully shot their month's pay and as much of Uncle Sam's equipment as they could get away with on the dancing dominoes. I wonder what are the German terms for *Snake Eyes, Little Joe, Big Dick, Phoebe, Ater from Decatur* and *Box Car Annie*? I'll wager you a small sum they have long, thumping double deck words—"

"Dear Bill," I said, "Your's of even date received and in reply beg to advise you are off the track and into the swamp up to your old yellow neck. This story is not about a crap game."

"Well, if it isn't," Bill inquired, "where did the old boy shoot the two bucks? Don't tell me he put it down on a pig at the Jockey club races."

"No," I said, "as you vulgarly express it, he did not put it down on a pig at the Jockey club. He shot the two bucks in the Black forest or up in the Hartz mountains, or—how do I know where he shot 'em? The paper does not state the exact location of the massacre. What's the difference anyway except to the two bucks? Yesterday they were gamboling on the green—I said gamboling—or whatever it is these dainty little creatures do to pass away the time and today their poor pitiful little carcasses are hanging up by the hind legs in the general's woodshed."

"I get you," said Bill. "My error, me boy, my error. You mean those animals with long horns, short tails and beards. They go jumping and yodeling from rock to rock and from precipice to precipice. Two bucks! Har, har. If you had said two billy goats the first time I would not have fallen into the natural error that you were referring to the kale, the long green, the spondulix, the ducats, in a word my lad, a 2-dollar bill.

"However," Bill continued, "when you consider how deeply the instinct for gambling is ingrained in human nature the world over, you must admit that I had some ground for the assumption that you were talking about some game of chance.

"I met a lad the other day recently returned from a trip to Oklahoma. He told me of a unique race staged every year near Ponca City that has every other event of the kind backed completely off the map. It is one of the few, if not the only race that is run absolutely on the level. Outside the trifling detail of entering the contestants, the men and women interested cannot interfere in any way with the result. "Another peculiar feature of this race is that age, sex, size, color or previous condition of servitude is not taken into consideration. Skill, endurance and speed present no advantages. A doddering old grandfather 200 years old stands as good a chance of creeping

THE BOYS WILL SING "MERRILY WE ROLL ALONG"

off with the prize, as the sprightliest young high stepper in the bunch of racers."

"Where do you get this 200-year stuff?" I asked Bill. "You have stuck on one nought too many. You mean 20 don't you?"

"No," said Bill, "I mean 200. According to what people tell me—I have no personal knowledge of the subject—according to what intimate friends of the family tell me, some of these things live forever, or almost forever."

"What things?" I was startled into asking. "For the love of Methusaleh's aunt Mary Anne what kind of a race are you talking about?"

"A turtle race," said Bill. "Didn't I tell you this was a turtle race, known far and wide as the Great American Terrapin Derby?"

"No," I said, "you did not. You have become so saturated with this political hokum and listened to so many the - man - I - am - about - to-nominate speeches, that you have contracted the disease. Go ahead. Tell me the rest of it. Appoint your committee to notify the turtles they have been nominated to run. At the rate you are going some of the more mature members will die of old age before the race is started."

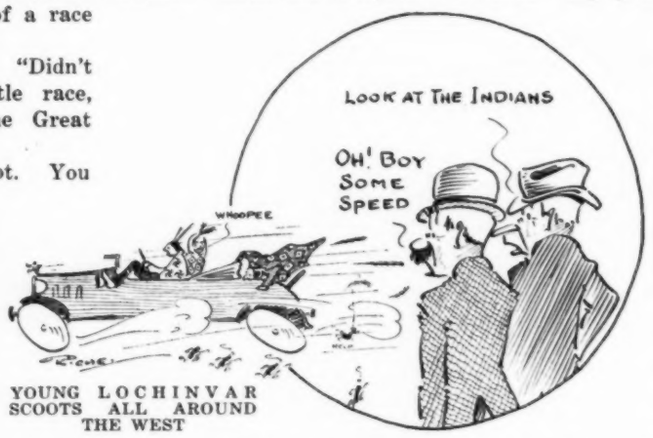
"Not a chance," Bill replied calmly. "Didn't I tell you these reptiles, or whatever they are, live forever?"

"If you did," I said, I have forgotten. I can't remember a thing forever, and if you think you can start an argument over whether a turtle is a reptile, a right angle, or a rip tailed roarer, you have another guess coming. Mush on! Dispense with the warming up exercises and get down to the race—if there was a race."

"Certainly, there was a race," Bill said. "What do you think this is, a chapter from *Trader Horn?* Come to think of it though, the old lad did not have any turtles in the mess of baloney. I wonder how he happened to skip 'em. He dragged in practically every other reptile, bird and animal that infest the Dark continent. He may remedy that in a later edition—if his fertile imagination does not give out."

"Wake me up," I said, "when the horses pass the barrier."

"That's another funny thing about this race," Bill said, "there was no barrier. All the plugs—I mean the turtles—got away to a standing start. That's the proper way to start a race, if you ask me. No jockeying for favorite positions, no cheating or other dirty work. The method of judging the winner was equally satisfactory. The racers were not even required to follow a definite course. They were allowed to choose their own course, to follow their own sweet will and set their own pace. In fact their absolute freedom of choice was carried to a point where they did not have to start at all unless the spirit moved them. Nothing could be fairer or more above board than that. Some of the ungrateful yellow dogs took advantage of this feature to the great grief and disappointment of their temporary owners. After the race, some of these short tempered owners derived a small measure of melancholy satisfaction by catching the renegades by the hind legs, raising them aloft and then knocking their empty heads with great violence against a convenient rock. Of all dumb brutes, a dumb turtle is the dumbest.



YOUNG LOCHINVAR SCOOTS ALL AROUND THE WEST

"Many of the people who attend the annual turtle race are recent or comparatively recent arrivals from the East, but the majority are descended from or intimately connected with the men who staged one of the greatest land rushes in history when the government of the United States 40 years ago threw part of the Indian Territory open to settlers. This was before oil was discovered and the only inducement offered was a section of free land which might be secured by staking the four corners and filing a claim at the nearest court house.

"Men from all the neighboring states, Texas, Missouri, Kansas, Arkansas, with others from more distant states to the north and east, particularly Indiana and Illinois, rushed there in such numbers that the government had to station soldiers on the border to hold them in check until the appointed hour arrived to officially open the territory.

"According to published stories and illustrations in the newspapers and magazines of that period the race developed into a stampede, every man for himself and the devil take the hindmost. They piled in there on horseback, on mules, on foot, in every size and style of conveyance. They quarreled among themselves and jumped claims on each other by day and night. Might was right. Possession was even better than the proverbial nine points in the law. A ready gun, an easy trigger finger and a reputation for accurate shooting from the hip constituted a better title than any trifling title deed duly drawn on legal caps and bearing the great seal of the commonwealth.

"Some years later the last remaining portion of free government land was thrown open in a similar manner and the helter-skelter performanace of earlier years was repeated. Honest homesteaders, adventurers, speculators and plain wildcatters, jostled and fought each other on the way, at the barrier of United States troops and afterward during the process of locating and filing. Up to this time, all the men wanted was land, either to cultivate or to hold for speculation. Then some person discovered oil and for years the mob scenes were enacted over again. Great hidden reservoirs of oil were tapped and a flood of flowing gold transformed backwoods settlements over night into metropolitan centers, with skyscrapers, opera houses, department stores and millionaires magnificent dwellings in the suburbs.

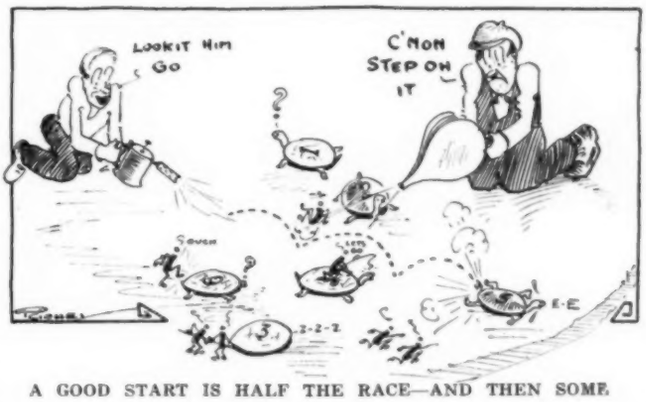
"Races? My dear lad the people down in that part of the country have been living in a racing atmosphere for the past 40 years or more. Even the native Indians are afflicted with the fever. At one time these people were the wards of the nation, pitiful poor relations, objects of charity. Today, they still are the wards of the nation, but through fortunate ownership of leased oil lands on which their good natured guardian, the United States government collects the royalties, each member of an Indian family enjoys an income of approximately $50,000 a year. As a result each family owns one or more of the highest powered and most expensive cars in existence.

"Drive? Say, listen. A car that under ordinary circumstances should serve a family for several years, is driven ragged by one of these birds in a year. Then he gets a new one."

"All interesting," I admitted carelessly. "If true," I added as an after thought, "but tell me, what has all that drivel to do with the turtle race you started to talk about?"

"Everything," Bill replied, "everything. The people are so fed up, tired of all ordinary races that they turn to a form of racing in which speed is no factor at all, for a rest.

"The rules are simple. Any person may enter a contestant by paying a nominal fee of $2. A level piece of ground is selected and three rings are marked upon it. The inside ring is 10 or 12 feet in diameter and the outer ring is 75 feet in diameter. Each turtle is marked by letter or number to decide his ownership. Some owners adopt extraordinary and bizarre color schemes. All the turtles are placed in the center under a cover. At the starting signal the cover is lifted and the turtles are free to move. Some do and some don't. The turtle that crosses the outside circle first cops the first prize of $4500. Other prizes are awarded to the second, third and fourth up to a total of $20,000. Just to illustrate the pure democracy of the thing, the turtle that won this year's race was picked up by a night watchman on his way home from work Sunday morning. He called the turtle *Sunday* and entered him, her or it—they all look alike—in the race and brave *Sunday* earned him more in half an hour than he could make in two years night watching.



A GOOD START IS HALF THE RACE—AND THEN SOME

"Yes sir," Bill continued, "the instinct for gambling is as old as original sin and it takes many queer forms. Foundrymen take chances all the time. Of course every mold that is made is a gamble more or less, but what I mean by gambling is where a foundryman goes out of his way to tackle an odd job.

I received an inquiry from a foundryman the other day who said he was interested in the production of a bronze bust and would appreciate any information I could give him on the so-called lost wax process of doing this work.

"I wrote him that instruction for making a bronze bust by the lost wax process is comparatively simple, but actually doing the work involves a high degree of skill acquired through a long period of training in this particular branch of the foundry art.

"The procedure varies somewhat depending on the size of the casting, also upon whether only one or several castings are required. If several duplicate castings are ordered a master mold in several parts is prepared in plaster and this may be used repeatedly for getting the wax impressions. If only one casting is required the mold may be made directly from the sculptor's clay model.

"Assuming that only one casting is needed the mold is rammed in the usual manner with French sand in a two-part flask with an opening in the end. The greater part of the clay model is removed in small pieces through this opening and then the mold is taken apart and the remainder of the clay is removed from the face. Strips of wax rolled to the desired thickness of metal are laid all over the face of the mold and then the two parts of the mold are placed together again. A suitable arbor is placed on the inside and the space is rammed full of sand. Pieces of wire from the core project through the wax into the mold at various points to serve as chaplets. The entire mold is placed in a hot oven where the sand is baked and the wax melts and flows down through suitable channels. The mold then is set up in a suitable position and poured through a number of small gates connected to a reservoir on top of the mold. An iron plug with a long handle is placed in the hole in the bottom of the basin or reservoir and is removed after a sufficient quantity of metal is poured in the basin to fill the mold.

"The procedure is slightly different where a number of duplicate castings are required. The clay model or a plaster cast may be employed for the first pattern. If necessary an existing casting may be used for a pattern. Usually a plaster replica is employed for a pattern, but as this usually is supplied by the sculptor it is not necessary at this time to describe how it is made.

"The plaster pattern is mounted on a suitable base and the plaster is built up around it in as many sections as may be necessary to remove readily. Small temporary wood frames are used to hold the plaster blocks until the plaster has set. This is a comparatively slow process since each block must be solid before the next block is built on top of it. Tapered grooves are cut in the top of each block to serve as guides in locating the block on top. Also each block is numbered or marked in a suitable number so that they may be assembled readily.

"After the pattern has been completely covered, the blocks are removed one at a time. Then the pattern is removed from the base and the blocks are reassembled. In some instances, particularly large molds, the interior of the mold face is covered with strips of wax as in the former instance. A small mold is filled with molten wax which is allowed to remain until the skin has set to a thickness corresponding to the desired thickness of metal. Then the remainder of the wax is drained out. Considerable experience is required to determine the proper time. The interior of the mold then is rammed full of sand and reinforced with an arbor as in the method first described. The plaster blocks on the outside are again removed and placed in storage. Then the outside of the mold is formed in sand or plaster after which the entire mold is baked and afterward poured. In another variation of the molding process a gelatin mold is formed first in a plaster cast from the model and the wax impression is formed inside the gelatin mold. The particular method adopted, depends to a considerable extent on the size and shape of the desired casting. The majority of foundries in this country employ French sand to make ornamental and statuary castings by the so-called *piece-mold* method. Description of this method has been published many times in THE FOUNDRY, for example in the July 1, 1925 issue, April 1, 1927 and June 1, 1927. However, as I said in the first place it certainly is no job for an amateur."

Pipe Foundry Pending

An arrangement has been pending between the Warren Foundry & Pipe Co., Phillipsburg, N. J., and the Mystic Iron Works, Everett, Mass., for the establishment of a foundry for small sizes of cast iron, bell and spigot pipe by the former company. The shop will be situated close to the Everett blast furnace. Property has not been acquired for this purpose, final action awaiting decision of the city to close permanently certain streets now traversing the prospective site of the plant.

QUERIES ON FOUNDRY PRACTICE

Suggested Solutions for Common and Unique Shop Problems

Place Extra Thick Sand Bottom in Cupola

QUERY

Some time ago we added a 6-inch ring to the bottom end of our 38-inch cupola so that we might collect a greater amount of metal before it was tapped into the ladle. This necessity no longer exists and recently we have been ramming a 9-inch sand bed on the bottom to save coke and restore the former distance between the bottom and the tuyeres. Do you think this extra thickness of sand will affect the temperature of the iron?

ANSWER

The thickness of sand in the bottom exerts no influence on the temperature of the iron provided the sand is in proper condition and is not rammed too hard. Practical demonstration of this is offered in cupolas of the solid bottom type, that is cupolas in which the bottom is not dropped at the conclusion of the heat. These cupolas are not used in America, but they have been used extensively and still are used to a considerable extent in European foundries. Sand is not a good conductor of heat, therefore in theory a thick sand bed should keep the iron hotter than a thin bed, through which the heat could radiate more readily.

Simply as a measure of convenience and a means of saving a certain amount of sand and the time of the cupola tender who rams it for every heat, we suggest you attach a lining to each half door to take up this 6-inch space. The lining could be made either from steel plate or cast iron and attached to the bottom door by three bolts passing through three 5-inch lengths of 1-inch pipe which would serve as separators.

Reclaims Spilled Metal

QUERY

We recently cleaned the ash pits beneath the pot furnaces in our brass foundry and reclaimed a mass of spilled metal. The pieces are large and, since we want to remelt them in an open-flame furnace and cast them into ingots, we would like to know of a way to break the pieces to a size suitable for charging into the furnace.

ANSWER

The easiest method is to place the pieces on the floor and turn the furnace with the opening down and let the flame play on them. When they are red hot break them with a sledge. An alternative method, if a hoist is available near the furnace, is to turn the furnace so that the opening is at the top and lift the pieces by use of the hoist to the top of the opening of the furnace. When they are red hot break them to the desired size with a sledge.

Iron Is Brittle in Glass Factory Molds

QUERY

Our glass factory customers complain that the molds which we make for them are brittle on the chilled face. We pour these molds from a mixture made up of No. 1 pig 50 per cent, machinery scrap 25 per cent and remelt 25 per cent. We use machine oil and cement on the face of the chills and we are wondering if this material affects the composition of the iron.

ANSWER

You may take some consolation from the fact that there never was and probably never will be a mold made to satisfy a glass factory customer. He wants a mold soft enough to finish readily, hard enough to impart a smooth finish to the glass and tough enough to resist alternate contraction and expansion forever. Up to the present no person has succeeded in developing an iron with these contradictory characteristics. However, the mixture you are using at present may be improved to a considerable extent by the substitution of bessemer or malleable pig and scrap for the ordinary machinery scrap and remelts. Also steel scrap may be added judiciously depending on the bulk of the casting. By using light chills you can secure the same effect on the face of a casting made from a strong iron mixture, as you might anticipate ordinarily from a heavy chill and a soft iron mixture. If the face of the mold actually was chilled, that is if all the carbon was in the combined form, it could not be tooled and finished. Your custom of covering chills with machine oil and cement is different from that usually practised, but we cannot see how this coating can effect the physical properties of the iron in the castings obtained by this practice.

Center Shaft Is Cause of Dirt in Roll

QUERY

I am having trouble with a chilled roll 16 inches diameter, 4 feet in length with a 6-inch square steel shaft in the center. I have poured it from the top, also from the bottom, but the face is dirty. The chill cracked the second time it was used. I shall appreciate your advice on this job.

ANSWER

The term *dirty* is so elastic in the foundry that we find it hard to present a direct answer to your inquiry. If the face of the casting really is dirty, that is if it contains deposits of slag or sand, then the obvious remedy is pay greater attention to the sand particularly around the runner. Also to see that the metal is clean in the ladle and that it is skimmed properly before it enters the mold. The most satisfactory method of pouring the casting undoubtedly is the one pursued in regular roll shops where the metal is poured into a funnel and dry sand runner outside the chill which conduct the metal to a runner set at a tangent close to the bottom of the mold. The tangential runner gives the metal a whirling motion which serves a double purpose. It carries any floating dirt to the open top of the casting and prevents the metal from forming ridges against the chill.

We are inclined to the opinion that your trouble is caused by the shaft in the center. Unless it is perfectly clean it will cause the iron to boil and this boiling iron in turn will show on the face in the shape of ridges, wrinkles and dirt caused by the scale burned off the face of the shaft. The ridges and wrinkles are caused by the erratic movement of the molten iron upward. Even if it is quite hot leaving the ladle, the chill on the outside and the shaft in the center soon reduce the temperature.

We suggest that the mold is poured at the botttom through a whirl gate. Heat the shaft to a bright red and then scrape off all adhering scale before it is placed in the mold. Heat the chill in the oven over night and then paint the inside with a light coating of molasses water and blacking. Finally pour the mold as rapidly as possible.

Charles Vickers Says—

(*Concluded from Page* 841)

vessel which have to be scraped away during transit to the next mold.

The partitioned or teapot ladle can be used in brass foundries specializing on heavy brass or copper, but the spout partition has to be carried straight down to the bottom of the ladle to be efficient. Some only carry it about two-thirds down. When the metal level gets below this point the floating dirt enters the tubular spout and has a straight flow into the molds. Once it gets into the partitioned-off spout it is beyond reach of the skimmer. Such ladles are highly efficient skimmers when the tubular spout is kept clean and the metal surface also is clean when pouring is commenced. At one time bottom-pour crucibles were made having the tubular portion carried to the bottom of the pot. These were exclusively used for copper by one brass foundry in Chicago specializing in commutator bars and such copper parts and were found to be a great improvement over the old methods of skimming with an iron bar. This type of crucible was invented by a dentist, who evolved a then new method of producing high conductivity cast copper.

Unfortunately the crucible makers insisted on making the pouring tube too small in diameter, and the foundryman had to file it larger. When too small, the copper is poured too slowly and sometimes it sets in the tube. The diameter of the tube should not be under 1½ inches for a No. 100 pot and in putting such a partition into an ordinary crucible, as was done in this case, the metal capacity is restricted too greatly. A bottom-poured crucible should follow the shape of the bottom-poured steel or iron foundry ladle shown in Fig. 2, where the spout does not lessen the capacity of the crucible to any great extent. The spout is placed outside the crucible and an opening at the bottom of the bowl leads directly to the bottom of the spout.

Molder Apprentices to Attend Lectures

During the past winter the molder apprentices of the General Electric Co., Schenectady, N. Y., had a series of lectures given by technical men of the company's staff.

The talks which with the discussion occupied an hour and a half were held once a week at 5 p.m., and the attendance was voluntary. The attendance record showed an average of 98 per cent for the series.

The lectures covered a variety of technical subjects such as metallurgy, making of steel, operation of the cupola furnace, operation of heroult electric furnace, history of founding, reduction of losses through scrap castings, holloware green sand molding, foundry planning, shrinkage and contraction, correction of design, and jarring machine molding.

Among the speakers were J. M. Sampson, superintendent of foundries; T. H. Trevithick, assistant superintendent of foundries; E. H. Heinen, general foreman foundries; A. D. Van De Bogert, assistant to superintendent; W. D. Schoonmaker, foreman of the iron foundry; J. Heffron, chemist, foundry department; T. A. Shea, steel foundry metallurgist; J. H. Woodward, apprentice instructor; William Hodges, testing laboratory; R. E. Ellis, superintendent apprentice department; N. Swart, inspector steel castings.

During this winter the lectures will be repeated and alloy founding and melting will be stressed.

Effects Savings in Heavy Mold Production

(*Concluded from Page* 846)

A fourth shop is devoted to work that goes in 47 x 56½-inch flasks. That department has a jar-ram, roll-over, pattern-drawing machine. The last two departments are equipped with six floor-operated jib cranes of 3000 pounds capacity each, and a 6-ton overhead crane and with a drying oven.

A. P. Lee has been in charge of all iron foundry work at Wm. Sellers & Co. Inc. for the last five years and during that time most of the developments described have been applied. Mr. Lee also has taken over the metallurgical work of the late A. E. Outerbridge Jr., who was connected with the Sellers company for a number of years.

Organize Foundry

Manufacturers Foundry Co., Holland, Mich., has been incorporated for $75,000 and will operate the plant of the Western Foundry Co. of that city which has been acquired by the following manufacturers: Western Machine Tool Works, Holland; Morton Mfg. Co., Muskegon Heights; Sanitary Sewer Basin Co., Chicago; and the Western Foundry Co., Chicago. The officers of the new company are Henry Morton, president and general manager, Muskegon Heights; Henry Winter, vice president; John Arendshorst, secretary; G. J. Bosch, treasurer; Paul Vander List, superintendent, all of Holland; and Nicodemus Bosch and Howard J. O'Neil of Chicago who form the board of directors of the new firm.

Book Review

Modern Foundry Operations and Equipment—by William Rawlinson, 312 pages, cloth, 5½ x 8½ inches, published by Chapman & Hall Ltd., London, and available through THE FOUNDRY, Cleveland, for $5, or by the Penton Publishing Co., Ltd., 416-417 Caxton House, London, S. W. 1, England for 25s.

The principles underlying various foundry operations are surveyed in an exceptionally thorough manner in this recent addition to the literature of the foundry industry. The publication deals with the production of iron, steel and nonferrous castings and is written chiefly with the viewpoint of supplying the needs of the engineer. However, the practical side of foundry operations has not been neglected in the preparation of the work.

A portion of the book is devoted to consideration of the various classes of metals available for castings purposes. Information is given regarding the source of the metals, methods and equipment used in melting, methods of preparing sand molds and cores, cleaning methods and equipment and tests which are followed. Under the heading of cast iron, the discussion includes information on the varieties of pig iron, chief characteristics, grading, mixing, effect of elements on cast iron, microscopical considerations, chemical changes in melting, strength of cast iron, etc.

The chapter on malleable cast iron includes a discussion of both whiteheart and blackheart processes, metals used, annealing methods, physical properties, etc. The author also devotes some attention to developments in cast iron and discusses semisteel mixtures, pearlitic iron and the effect of adding special elements to cast iron. The various types of melting, including crucible, acid and basic open hearth, converter and electric furnace are featured in the chapter on steel castings. Other features discussed under the steel heading are as follows: Annealing, molding and drying, chemical and physical properties, etc. Various types of aluminum alloys and methods of melting are discussed.

Equipment described includes cupolas, electric furnaces, crucibles, converters, open hearths, noncrucible furnaces, types of fuel employed, molding machines, cleaning equipment, etc. A special chapter also is devoted to core shop operations.

The Shakeout

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WORK of the committee did not end with the publication of the standards. A study of the various tests indicated that certain minor changes were essential and these were made. New tests were developed to cover the sintering quality of sand, strength of baked core sands and grading and classifications for grain size and clay content. A volume covering the revisions in tests and the new tests recently has been published by the A. F. A. and distributed to those members requesting a copy. Undoubtedly, that publication, containing the standard and tentatively adopted methods of testing and grading foundry sands, is one of the most valuable contributions to the literature of the industry ever made by the association. The foundry industry as a whole is deeply indebted to the A. F. A. and to those members of the joint committee who have labored diligently in this service.

M ¶ Mosaic and the Golden Rule

MOSES gave the tribes a code of laws consisting of ten commandments and this system of government of the Israelites became known as the Mosaic law. Similarly, since the earliest dawn of the time, when humans were gathered together some rules of conduct have been necessary to circumscribe individuals in their relations one with another. With the growing complexities of what is termed civilized society, these codes of conduct have multiplied. From laws which say, thou shalt not, humanity has progressed along the upward path to statements of principle which say, we will not.

IN THESE latter days of 1928, industries through their several associations are going another step along the line with the formulation, adoption and observance of various codes of trade practices. Those which are worthy of note in the foundry industry have been commented upon from time to time in the pages of THE FOUNDRY. The ideals which lead to these various statements of business principle are right. That they are observed by the majority of those who have advanced them may be accepted; and that exceptions or non-adherence quickly are met by rebuke has been affirmed in many instances.

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Trade Trends in Tabloid

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No. 2 foundry, Buffalo	17.50
Basic, Valley	17.25 to 17.50
Basic, Buffalo	17.00
Malleable, Chicago	18.50
Malleable, Buffalo	18.00
Coke	
Connellsville foundry coke	$3.75 to 4.85
Wise county foundry coke	4.50 to 5.25
Scrap	
Heavy melting steel, Valley	$15.00 to 15.50
Heavy melting steel, Pitts	16.50 to 17.00
Heavy melting steel, Chicago	13.25 to 13.75
Stove plate, Buffalo	13.75 to 14.25
Stove plate, Chicago	11.50 to 12.00
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.75 to 15.25
No. 1 cast, Philadelphia	16.25 to 17.00
No. 1 cast, Pittsburgh	14.25 to 14.75
No. 1 cast, Birmingham	16.00
Car wheels, iron, Pittsburgh	15.50 to 16.00
Car wheels, iron, Chicago	13.00 to 13.50
Railroad malleable, Chicago	15.00 to 15.50
Agricultural Mal., Chicago	13.00 to 13.50
Malleable, Buffalo	15.50 to 16.00
Railroad malleable, Pitts	14.00 to 14.25
Nonferrous Metals	Cents per pound
Casting copper, refinery	14.90 to 15.00
Electro copper, producers	15.25
Straits tin	49.50
Lead, New York	6.50
Antimony, New York	11.50
Nickel, electro	37.00
Aluminum, No. 12, producers	23.00
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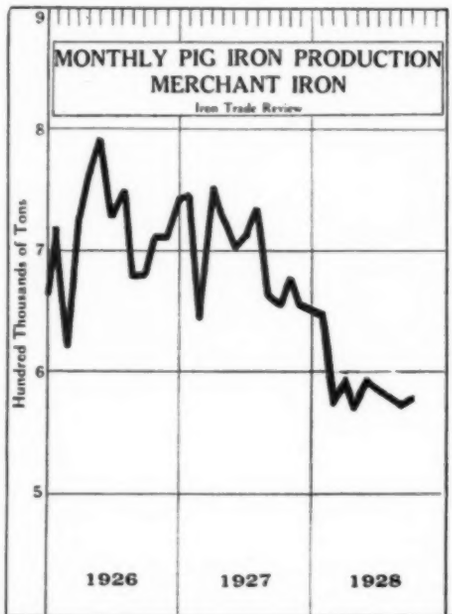
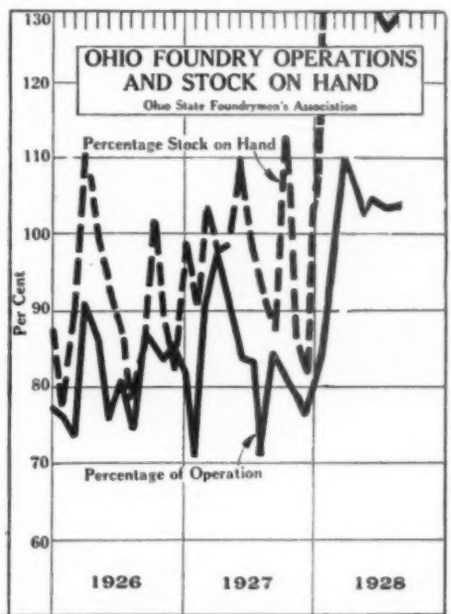
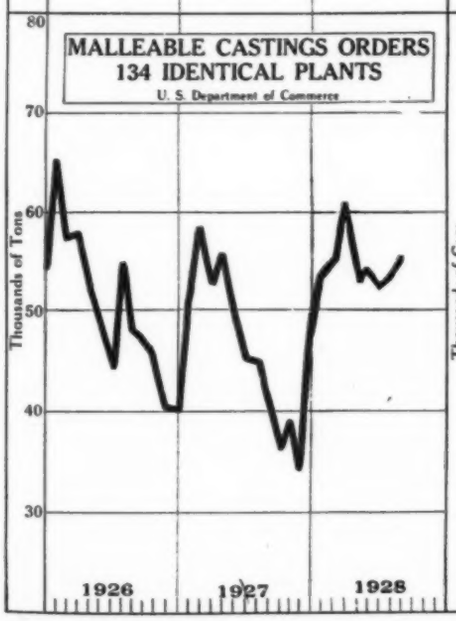
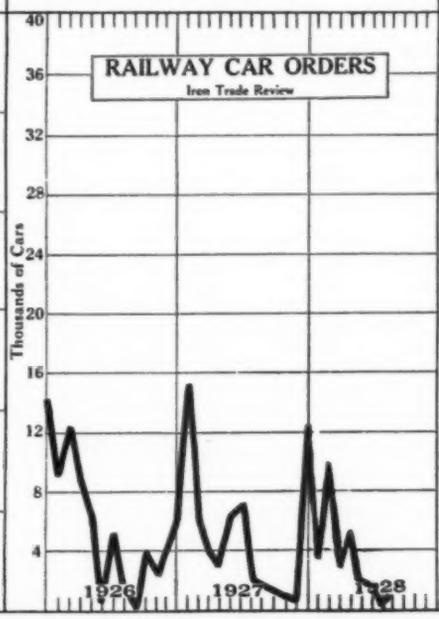
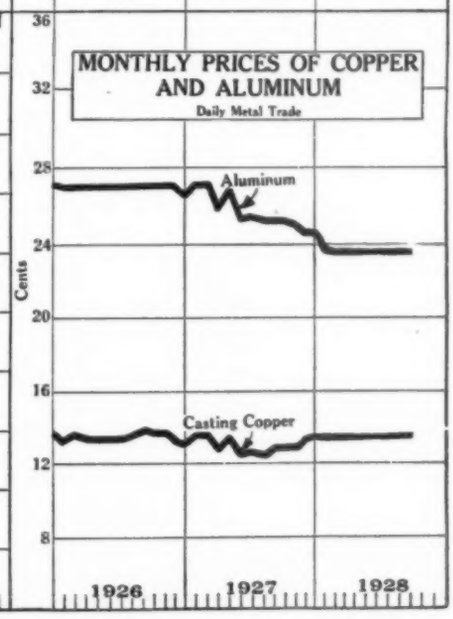
Zinc, East St. Louis, Ill.	6.25











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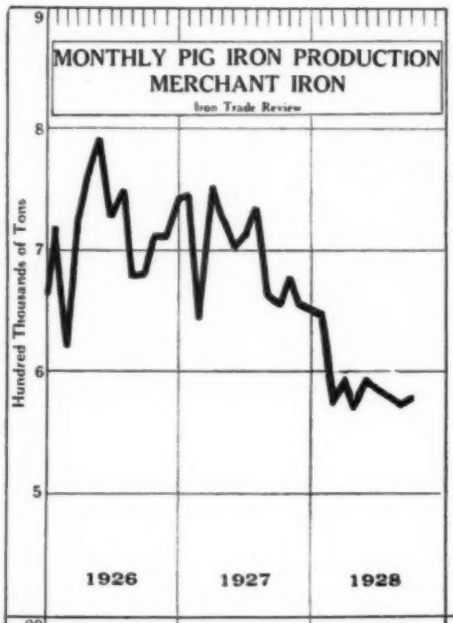
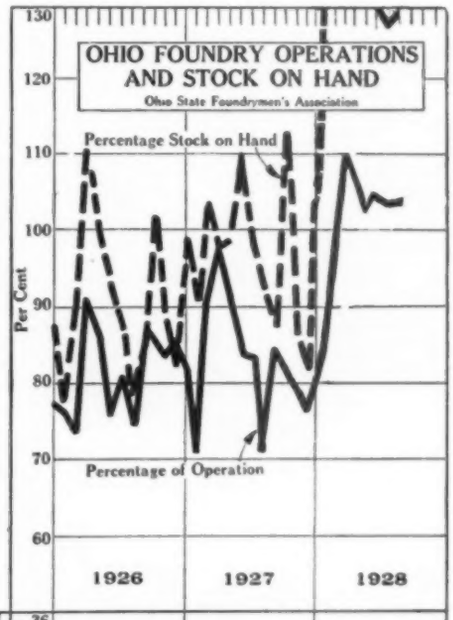
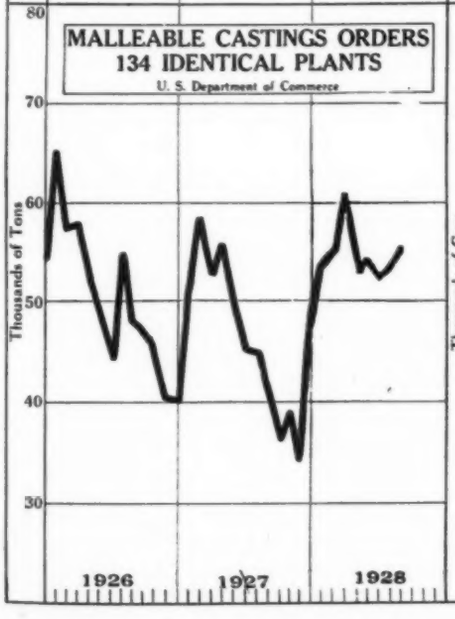
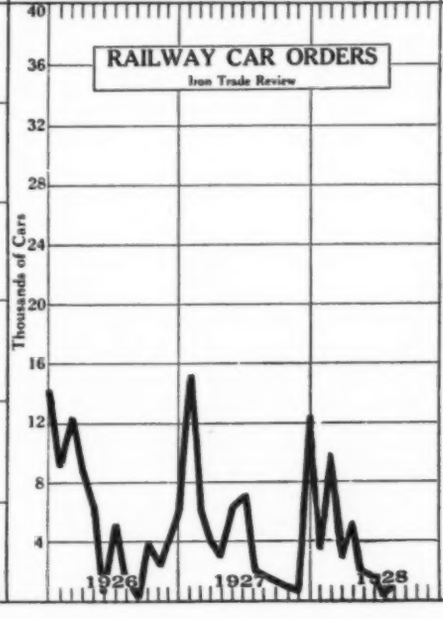
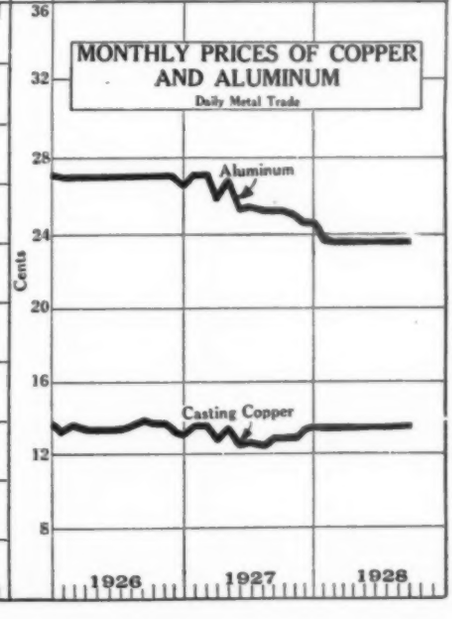










Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

ANDREW C. DENISON has been made president of the Fulton Foundry & Machine Co., East 75th and Morgan avenue, Cleveland, succeeding A. E. Gibson who resigned. Mr. Denison, who received his early education in the public schools of Cleveland, was graduated with a degree in chemical engineering from

ANDREW C. DENISON

Case School of Applied Science in 1910. His first foundry connection was with the Ferro Machine & Foundry Co. where he was employed as assistant in engineering layout and in charge of inspection. Later Mr. Denison became assistant to the superintendent of that company, J. Smith. He later entered the employ of the Fulton Foundry & Machine Co. where for six years he was employed in various capacities involving mechanical operations and estimating. In 1921 Mr. Denison was made manager of the Euclid Foundry Co., Euclid, O., a position which he held until his resignation recently to become president of the Fulton organization. He has been active for a number of years in foundry affairs and has been prominently identified with the activities of a local group of the Ohio Foundries Association, Inc., formerly known as the Ohio State Foundrymen's association.

M. Berg, formerly connected with the Stearns Conveyer Co., Cleveland, and more recently, assistant general manager of the Euclid Foundry Co., has been made general manager of that organization, succeeding A. C. Denison.

A. E. Gibson has resigned his positio as president of the Fulton Foundry & Machine Co., Cleveland, to become works manager of Wellman, Seaver, Morgan Co. of that city.

Jack Davis has resigned his position as foundry foreman with the M. Hoagland's Sons Co., Rockaway, N. J., to accept a position as foundry superintendent with the Springfield Foundry Co., Springfield, Mass. Mr. Davis is a foundryman of 16 years experience and has held various positions with R. Hoe & Co., Dunellen, N. J.; William P. Laytham Sons Inc., Paterson, N. J., and many other foundries.

J. J. Zimmerman, who recently was made production manager of the Elliott Co., Jeannette, Pa., has had a wide experience in the foundry and steel industry. He served his apprenticeship in the shops of the Cambria Steel Co., Johnstown, Pa., following which he was draftsman for that company and later for the U. S. Steel Corp. at its Homestead, Pa., plant. Later he was made assistant superintendent of the Scott foundry of the Reading Iron Co., Reading, Pa. A number of years ago he accepted the job of planner with the Elliott company and has engaged in the duties of that position until his recent advancement.

Canadians Hold Meeting

A meeting of a number of the leading foundrymen in the Montreal district was held at the Engineers club, Montreal, Que., on Wednesday, Sept. 12. The meeting was sponsored by Witherbee, Sherman & Co., Port Henry, N. Y., and their Canadian sales agents A. C. Leslie & Co. Ltd., Montreal, Que. Forrester B. Leslie acted as chairman. Dr. Richard Moldenke gave a talk on some recent developments in the foundry industry, after which the meeting was turned into an open forum. This meeting was held for the purpose of fostering a better understanding between foundrymen and blast furnacemen.

Speaks Over Radio

The plumbing industry has entered the field of radio broadcasting. Recently the Hajoca Corp., Philadelphia, presented its initial program over station WIP preceded by a short talk by its president, William A. Brecht. In his speech, Mr. Brecht spoke of the many benefits derived from modern plumbing equipment and the part it plays in safeguarding the nation's health. He told how the government, realizing the importance of proper in-

J. J. ZIMMERMAN

stallation of plumbing fixtures, has passed laws governing sanitary work. In closing Mr. Brecht gave a short description of the Hajoca Corp. and its products. A booklet was published by this company entitled "According to Law," containing the speech.

Hold Joint Meeting

The Quad-City Foundrymen's association held a joint meeting with the American Society for Steel Treating on Oct. 15. The meeting was addressed by F. D. Coyle, International Nickel Co., New York who spoke on alloy cast iron.

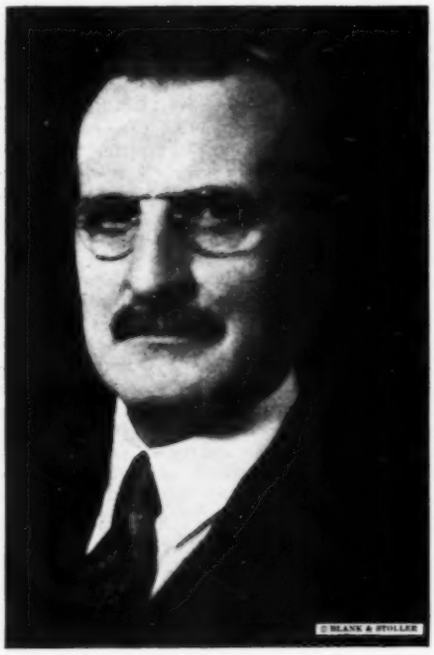
Stove Shops Flourish

Nashville, Tenn., is one of the centers of the furnace, stove and range industry. Three of the large companies making these articles are: Gray & Dudley Co., Phillips & Buttorff Mfg. Co., and Allen Mfg. Co. The latter company recently shipped two trainloads of furnaces.

Establishes New Firm of Engineers

E. S. Carman recently has established Edwin S. Carman Inc., Engineers. With the formation of this new organization Mr. Carman has resigned as secretary and chief engineer of the Osborn Mfg. Co. He continues to hold a stock interest in the Osborn company and that company becomes his first client.

Edwin S. Carman Inc. will handle general and industrial engineering, giving special attention to foundry problems, consulting, surveys, reports,



E. S. CARMAN

production, product design, plant design, plant remodeling, foundry operation, continuous molding, sand treating and testing, cost reduction. The offices are located in Carnegie Hall, Cleveland.

Mr. Carman began his work in the shop of the Sun Oil Co., Toledo, O. and four years later entered the engineering field with the American Machine & Mfg. Co., of Cleveland. In 1908 this company was consolidated with the Johnston & Jennings Co., Cleveland, and Mr. Carman was appointed chief engineer and manager of the engineering and machine department.

The Osborn Mfg. Co., of Cleveland, manufacturers of and dealers in wire, bristle and fiber brushes and wheels, hardware specialties, foundry supplies and equipment, early recognized the possibilities of making foundry molds by machine power and decided to enter that field. In 1908, Mr. Carman was engaged by the company to design, manufacture and build up a complete line of foundry molding machines.

In 1913 Mr. Carman became directly associated with the Osborn Mfg. Co., as chief engineer in charge of engineering and manufacture of the machine division, and in 1916 he was elected secretary and appointed works manager of both the machine and brush divisions of the company.

For a number of years Mr. Carman has been prominent in the activities of engineering societies. After serving it in several capacities, he was elected president of the Cleveland Engineering Society, and completed his service in this office in June, 1920. He was first chairman of the Cleveland Section of the American Society of Mechanical Engineers, which was authorized in December, 1918. He was subsequently appointed one of the A.S.M.E. delegates to the Washington Conference on June 3-4, which resulted in the organization of the Federated American Engineering societies. He was made president of the American Society of Mechanical Engineers in 1921.

Organizes New Company

John L. Cummings Co., St. Joseph, Mich., has been organized to manufacture refractories and specialties for foundries. Work soon will be started on the plant at St. Joseph, the first unit of which will be 66 x 100 feet. It is planned to begin operations late in December. The officers of the company are John L. Cummings, president and treasurer, and J. R. Osterberg, Riverside, Ill., secretary. For the past ten years Mr. Cummings has been associated with the S. Obermayer Co., Chicago, as manager of the refractories department, and formerly was with the Quigley Furnace Specialties Co. Inc., New York. Mr. Cummings is secretary both of the refractory committee of the American Foundrymen's association and of the joint committee on refractory materials.

Obituary

George F. Simpson, for many years president of the J. F. & G. F. Simpson Iron Foundry, Brooklyn, died Aug. 29, aged 78, in Allenhurst, N. J.

Nelson J. Teeter, 91, from 1864 to 1912 connected with the Grimsby Foundry Co., Ltd. Grimsby, Ont., died Aug. 31, at Grimsby. He was superintendent of the foundry when he retired from business 16 years ago.

Walter C. Arthurs, president, Mt. Vernon Car Mfg. Co., Mt. Vernon, Ill., died Sept. 16, while returning with his family from Hackensack, Minn., where they had spent the summer vacation.

Death has ended the long and active life of C. L. Tittle, Blairsville, Pa., one of the oldest founders in the United States. He died Aug. 30, from a complication of diseases. Mr. Tittle was identified with the foundry business since 1861 when he entered his apprenticeship with the old Cambria Co. He worked in various capacities in many foundries throughout the

JOHN L. CUMMINGS

country and in 1877 he purchased a small foundry from Samuel Ray in which he took an active interest until his death.

Clarence F. Hotchkiss, president of the Stow Mfg. Co., Binghamton, N. Y., died Sunday morning, Sept. 9, after suffering a heart attack. He was 69 years old. Mr. Hotchkiss' early life was spent in Unadilla Forks, N. Y., where he received his education attending two private schools in that community and completing his schooling at the West Winfield academy at the age of 18 years. He then entered the produce field as a commission man in the Unadilla district and later in Rome, N. Y. Mr. Hotchkiss removed to Binghamton after two years to become associated with Crandall, Stone & Co. as a salesman. In 1886, with the late Charles C. Warner, he purchased the interest of Nelson Stow, inventor of flexible shafting, and nine years later he purchased Mr. Warner's interest. He proceeded with the incorporation of the company and continued its direction until his death.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Lavelle Foundry Co., Anderson, Ind., reports business good.

Dana Foundry, Platteville, Wis., was damaged to the extent of $2000 by fire recently.

Dedman Foundry & Machine Co., Houston, Tex., was damaged by fire recently.

Lindgren Foundry Co., Batavia, Ill., plans the construction of a foundry building addition, 30 x 60 feet.

The Challenge Mfg. Co., 13-15 Wilcox street, Ashtabula, O., had a severe fire which damaged its foundry.

The Canadian Iron Foundries Ltd., Montreal, Que., has a contract for the guard work on a lift bridge to be erected on the Welland canal at Welland, Ont.

Anderson Stove Co., Anderson, Ind., plans expansion of its properties when the new North Anderson sewer is completed.

Lakey Foundry & Machine Co., Muskegon, Mich., reports business good and its foundry working at capacity.

Link-Belt Co., Indianapolis, has awarded the structural steel contract for building construction to Insley Mfg. Co.

Zenith Foundry Co., 567 Seventy-fifth avenue, West Allis, Milwaukee, is building a shop addition costing about $20,000.

United States Aluminum Co., Harvard avenue, Cleveland, has started the erection of a new $250,000 office and warehouse building.

The New Departure Mfg. Co., Bristol, Conn., has closed on 300 tons of structural steel to the Berlin Construction Co. for a plant addition.

Kewanee works of the Walworth Co., Kewanee, Ill., has been shut down for repairs but has resumed work on its regular schedule.

Forest City-Walworth Run Foundries Co., Cleveland, will rebuild the building burned in a fire Sept. 16. The new building will be used for a finishing and shipping plant.

United States Cast Iron Pipe & Foundry Co., Birmingham, Ala., has awarded the contract for structural steel for building additions to its pipe shops to Virginia Bridge & Iron Co.

Baker-Perkins Co. Inc., Saginaw, Mich., C. Pletcher, manager, has awarded the general contract for a foundry addition to James Kerns & Sons, Hess street.

Reading Casting Co. has changed its address from Reading, Pa., to Monocacy, Pa. The plant of the company has been moved to the latter city.

Wessling Bros. Foundry Co., McLean and Sherman avenues, Cincinnati, A. G. Wessling, manager, contemplates the construction of a foundry building.

Dominion Radiator & Boiler Co., Toronto, Ont., plans extensive improvements to its Brantford and Toronto plants. An appropriation of $500,000 has been made to carry out the work, about 60 per cent to be spent on the Toronto plant.

Active Pattern & Model Co., 1149 West Harrison street, Chicago, has awarded the general contract for a 1-story plant addition, 28 x 40 feet, to Industrial Construction Co., 53 West Jackson street, Chicago.

International Harvester Co. of Canada Ltd., Sherman avenue north, Hamilton, Ont., has awarded contract to Humphrey Bros., 214 Wellington street east, for the erection of a foundry addition, 1-story, 60 x 120 feet.

Taylor Iron Works & Supply Co., 1014 Broadway, Macon, Ga., W. A. Taylor, president, plans to double the capacity of its plant and will build three buildings, including a foundry, pattern shop and boiler shop.

McManus Steel & Iron Co., 3290 Wight street, Detroit, has been incorporated with 150,000 shares of no par value stock to manufacture and deal in steel and iron castings of all kinds, by Patrick J. McManus, Detroit.

Ohio Steel Foundry Co., Springfield, O., plans the erection of a new pattern storage shop and other buildings as part of its expansion program to be put into effect in the near future.

AC Spark Plug Co., Harriett and Industrial avenue, Flint, Mich., is inquiring for heat treating ovens for the proposed 1-story manufacturing plant 144 x 275 feet for die casting department.

Precision Castings Co., Syracuse, N. Y., is planning the construction of a new plant, which will be situated on Berea road, near West 117th street, Cleveland, and will contain 30,000 square feet of floor space.

Motznik Bros. Pattern Works, Cuyahoga Falls, O., has passed to the sole ownership of R. Motznik, who has begun the manufacture of barbecue ovens for gas and charcoal use. The manufacture of wood and metal patterns is being continued.

Hayes Malleable Iron Co., 231 South LaSalle street, Chicago, has been incorporated with 4000 shares no par value stock to manufacture and deal in iron, steel and other metals by Maurice A. Riskind, Leroy Weis and Samuel A. Litman.

Daniel C. Eagan and the Pennsylvania Title & Trust Co., Philadelphia, have been named receivers for the Eagan-Johnson Steel & Iron Co., Crum Lynne, Pa., by Federal Judge Dickinson at Philadelphia, pending an accounting to ascertain the financial status of the company.

Doehler Die Casting Co., Batavia, N. Y., has purchased the Metal Mold Castings Co., Winchester avenue, Buffalo, and will move the latter's production to Batavia early in 1929. The Doehler company will use metal mold processes to produce heavy aluminum castings in its Batavia plant and plans enlargement of production.

Erie Foundry Co., West Twelfth street, Erie, Pa., plans the construction of an addition to its plant and has awarded the general contract to the Henry Shenk Co. and the Erie Steel Construction Co. Work of demolishing the building housing the machine shop will start at once.

Aluminum Steel Products Co., Plainwell, Mich., has been organized to manufacture aluminum levels and aluminum castings. It has rented the former local plant of the Wolverine Casting Co. and has installed machinery removed from the plant at Royal Center, Ind. The company is prepared for operation and no additional equipment will be purchased.

Barbour-Stockwell Co., Cambridge, Mass., is now under full production in its new brass foundry. The foundry is housed in a modern, well-lighted, brick building, 40 x 60 feet, with overhead traveling crane. One end of the building has the cleaning department, a stockroom and washroom. The other end has the molding and pouring floors with six furnace pits, with a capacity of about three tons of brass a day. The molding floor has a jolt squeezer molding machine and other machines will be installed. The foundry is in charge of Edward Lyons.

New Trade Publications

CONVEYORS—Mathews Conveyor Co., Ellwood City, Pa., emphasizes the use of conveyors as a means of keeping material moving and avoiding congestion in a recent bulletin. The method of obtaining this result is illustrated.

SLING CHAINS—S. G. Taylor Co., Hammond, Ind., has published a revised blueprint containing data relative to safe working loads of its sling chains at various angles and giving suggestions relative to the proper use of chains.

CONVEYORS—The Lamson Co., Syracuse, N. Y., has issued a folder illustrating and describing its new gravity conveyor. An illustration is included on which is pointed out the various features of the apparatus.

DRILLS, GRINDERS, BUFFERS—Hisey-Wolf Machine Co., Cincinnati, has issued a booklet with information about its many kinds of drills, grinders and buffers. Pictures, accompanied by text explain and illustrate the uses for the machines.

RESISTANCE THERMOMETERS—A new catalog by the Leeds & Northrup Co., Philadelphia, covers its line of resistance thermometers, precision and semiprecision thermometers, recorders, controllers and accessories. Illustrations show installations of various types and details of construction. Diagrams show operation. The Wheatstone bridge theory is discussed and definitions of pyrometric terms are appended.

SCRUBBERS—D. J. Murray Mfg. Co., Wausau, Wis., has recently published a 15-page bulletin covering its air and gas scrubbing apparatus. The booklet deals with the construction, operation, and installation of the machines. A half section of the scrubber and several of its most important parts feature the catalog. Its advantages and application to many industries are discussed. Layouts of several of these suggested uses are included.

ARC WELDING—General Electric Co., Schenectady, N. Y., has issued two brochures, one dealing with arc welding in its own plants and the other with arc welding problems in industrial plants. Both booklets are well illustrated and show a great many uses for which arc welding has been employed. Accompanying these brochures are several bulletins, some dealing with arc welders, and others with motors for portable hoists.

BLOWERS—Wilbraham-Green Blower Co., Pottstown, Pa., has issued a 15-page bulletin on its rotary positive type cupola blowers. It includes a short history of the company, list of advantages of its types of blowers, and a table of sizes and capacities. Diagrams of construction, and illustrations of the various types of machines with typical installations also are included. In the future this company will build its blowers for foundry purposes, fitted with heavy duty Hyatt roller bearings.

PUMPS—Pennsylvania Pump & Compressor Co., Easton, Pa., in its bulletin No. 212, decribes its multi-stage centrifugal pumps. Pictures of installations of the various types of pumps are spread throughout the bulletin. Another feature of the bulletin is that it contains a description of the company's high pressure boiler feed pumps. Diagrams and pictures of parts of the pumps make up the closing section of the bulletin. Bulletin No. 138 of this company has been issued also, illustrating and describing its air cushion valve.